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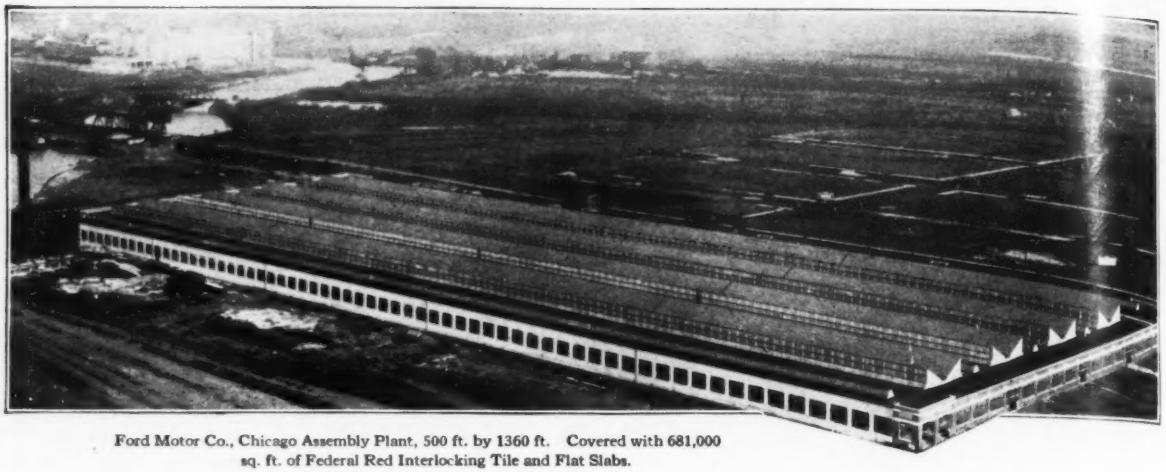
An Analysis of the Grading Curve for Concrete, *by L. I. Hewes*—Building Pile Foundations for a Marsh-land Factory, *by R. L. Hart*—Official Report of the Gleno Dam Failure in Italy—Design and Layout of a Modern City Freight Terminal: 1—Geodetic Survey Makes Precise Ice Traverse in Minnesota, *by Casper M. Durgin*

Tracing the International Boundary Across the Minnesota Lakes with the Thermometer at 40 Degrees Below Zero



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DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

FRANK C. WIGHT
Editor

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Centenarian Engineering

IT IS customary to think of engineering as a young science, or art, with little background and no history to speak of. But time moves faster than we give it credit for. This year three centenaries are being celebrated—all significant to engineers. In 1824 Joseph Aspdin patented a new building material that came to be known as portland cement; in 1824 Stephen Van Rensselaer founded in Troy that polytechnic institute that bears his name, and in 1824 several of the first railways put forth across England their tiny tentacles. All three events are to have appropriate ceremonies, which will remind engineers that the modern development of their profession after all has reached a dignified age.

Changing the Contractor's Name

WHILE we sympathize thoroughly with the motive behind the effort to escape the unpleasant connotations of the word "contractor" which Mr. Wilson, in our correspondence columns this week, so feelingly describes, we have our doubts as to the ultimate success of the effort to substitute the word "constructor." Language is an unruly thing. It makes itself. Words come into being without conscious effort on anyone's part and meanings change in utter disrespect for the dictionary. The great god of language is usage, and as becomes a god, it conforms to no man. "Realtors" remain real estate agents to the man who is not one; "electragist" is only a high-toned name for an electrical goods dealer and no one outside the industry knows even that. Unless our friends the contractors have some mystic formula they can hardly hope to be any more successful in bending the common tongue to their own desire.

Who Should Teach Spanish?

SPANISH is taught in our universities and technical schools mainly for its practical value and not for its cultural influence. Spain, its history and its civilization, is of secondary importance to the newer Spanish-speaking countries which lie to the south of us. They are the peoples we have in mind when we teach Spanish to our youth who, especially if they are to become engineers, may be expected more and more to do business in Latin America. A criticism of an eminent Uruguayan engineer and professor, who has just completed the highway tour of the Pan American Highway Commission, is most pertinent. He says that so far as he was able to observe the teachers of Spanish in our schools are from old Spain, except where Americans themselves are professors, and he makes the very pertinent observation that the desired good feeling between the two Americas would be measurably promoted were Latin Americans selected to teach Spanish in our schools, and were the teaching of Spanish made more to hinge upon the Spanish of South and Central America than upon the culture of classic Castile. The criticism seems valid; it is offered for the consideration of university faculties.

The Wooden Car Again

THE death of three prominent engineers, President McNair, Professor Ives and Secretary Dunlap, as a result of the rear-end collision at Buda, Ill., June 30, will focus attention of other engineers on the fact that the car in which all the passenger fatalities occurred was of all-wood construction. Ahead of it were all-steel cars; behind it were two wooden cars with steel underframes. One of these steel-underframe cars ploughed along through the side of the wooden car leaving terrible destruction in its wake. Whether the same thing would have occurred had the car been of steel none can say definitely, but it has occurred too frequently to leave any doubt in the minds of most people. The all-wood car has no place in among steel cars; if it must be used it should be on the end. That it should be used at all is doubtful. Certainly such cars should not be used in main-line service; they should be relegated to branch line service where the shocks they have to stand are less. Probably the Interstate Commerce Commission, in its report on this accident, will say that some form of automatic train-control would have prevented this accident. Obviously that is true but the ultimate attainment, a railroad system completely equipped with automatic control, is in the distant future. In the meantime more careful supervision of the make-up of our passenger trains will do much to reduce the fatalities in railroad accidents.

Haste in Automatic Train Control

SIX MONTHS of intensive development of automatic train-control has not convinced the Interstate Commerce Commission that the railroads were right in their repeated claim that although one type of train-control had been in successful operation for a number of years the art of automatic train-control is still in its development stage, and that other and more efficient types would be developed. The one type that has been in successful operation is the intermittent ramp type. Most railroad signal men believe that this type will not be adopted ultimately and therefore are loath to spend money installing it. They are certain that some form of inductive control, either intermittent or continuous, will ultimately succeed it. For this reason some of the larger companies are making installations of two or more different types to assist in their development before deciding what type they will adopt for their systems. Naturally they are asking for an extension of the time in which the first installations of one whole division must be completed. The commission has denied this extension to all but the 42 minor railroads mentioned in its second order. The reason for this action is not clear. The evident intention of the second order,

issued last January, was to spur the railroads on to more aggressive action in aking extensive installations. It had that result, but to complete all the installations ordered completed by Jan. 1, 1925, is now a physical impossibility. This fact will have to be recognized by the commission in January; it should have been recognized in the order issued last month. The development of the art of automatic train-control would have been served better by an order encouraging the development of the most efficient type rather than by one tending to force the adoption of a less efficient type simply because that type was the first to be put into successful operation. The need for automatic train-control is unquestioned but this fact does not justify saddling the country with thousands of miles of one type when a year or two more of study will result, in all probability, in the development of much better types.

Quantity Piledriving

OF ALL methods of obtaining sub-surface support of heavy structures the wood pile is the oldest. When groundwater keeps all the pile wet and marine borers do not infest the water no method of support is more permanent. Both favoring conditions prevail at the site of the new plant of the Western Electric Co., whose pile foundations are described in this issue. It is not out of place to quote these elementary facts in recording one of the largest, in number of piles driven, if not the largest pile foundation which has ever been built. There were 38,000 piles driven for the units at present under construction and these units constitute only about a fifth of the factory structures which are planned. Assuming the continuation of pile supports for the future units 200,000 trees will be consumed in making solid the footing of one of the larger of the great industrial plants constructed in recent years. Now 200,000 trees make a considerable forest even where growth is the densest. But it is less the magnitude of the operation and more the construction procedure that attracts attention to the great task of piledriving. For the building foundations the piles were driven before the excavation for the concrete footing mat and basement structures. With followers the piles were sunk eight to ten feet below the marsh surface to subgrade elevation. When later the excavating machines came onto the ground their operation was as free as if no piles had been driven. The top earth was skimmed off and the piles exposed. There was a distinct saving of time by this procedure as the article describing the operation clearly indicates.

Gaining Ground

MUNICIPAL programs are gaining ground. Like city planning they are replacing the old and still general practice of dealing with each public improvement singly, instead of as a part of the orderly interrelated development of all the public works and services of the city. Programs and comprehensive plans go together, the program being the time element in the plan. As might be expected, the more progressive chambers of commerce are promoting municipal programs. A current example of this is afforded at Newark, N. J., where the Chamber of Commerce, through E. W. Wollmuth, executive secretary, has urged the City Commission to adopt a comprehensive plan for municipal improvements which "could be consistently followed according to some definite sequence." In discussing a specific street project Mr. Wollmuth asks: (1) Is it essential either in itself or as a part of the arterial street system; (2) what is "its relative importance and proper sequence"; (3) how will its cost be distributed between the property owners affected and the taxpayers generally? Heretofore, Mr. Wollmuth says, and this is of almost universal application: "The emphasis has focused on the merits of the individual project. . . . There has not been that recapitulation of improvements and public expression as to their relative importance to which the commissioners could refer an enthusiastic but perhaps premature demand for street extensions." All this is sound doctrine which should be reduced to practice in Newark and in all other cities that have not already done so—and their number, at least in America, is small.

Six Wheel Trucks

HIGHWAY engineers will welcome the announcement that a new company has been formed to develop and manufacture six-wheel motor trucks. They have watched the ever increasing number of trucks and the increasing loads with a certain amount of dismay. Axle loads on the rear wheels of commercial trucks and buses have reached a point where one season of insufficient funds for maintenance may result in the conversion of a fair gravel or macadam pavement into a mass of ruts and potholes; where small holes in more permanent pavements may become a real source of danger in a few days, and where bridges, built before the advent of motor trucks, are frequently loaded to beyond their safe limits. The transfer of these concentrated loads from a single pair of wheels to a four-wheel truck is a long step in the right direction.

A New School of Public Health

THE announcement that post-graduate work leading to the degree of doctor of public health is now offered at the Massachusetts Institute of Technology is important news. For thirty years or more the Institute has been supplying sanitary engineers, chemists and biologists to municipalities, states and the federal government for work directly and indirectly in the field of public health. Many of these, including a goodly number of engineers, have become municipal health officers. For some time, the M. I. T. and Harvard University jointly maintained the Harvard-Technology School of Public Health, but it came to an end with the Rockefeller endowment of the Harvard School of Public Health. That and the death of Dr. William T. Sedgwick were setbacks to public health work at the M. I. T., but meanwhile the work of the Institute's Department of Biology and Public Health so long and efficiently directed by the late Dr. Sedgwick has been ably carried by his long-time associate and ultimate successor, Dr. Samuel C. Prescott. As might be expected from all who know of the health work and spirit at the M. I. T., an M. D. will not be required for a health doctorate at the M. I. T. This is justified both by the nature of the work of the health officer and by the records of the many engineers and sanitarians who, with only their training in sanitary engineering or chemistry or biology and public health, have done notable work as municipal health officers throughout the land.

Standardizing One-Inch Lumber

SPEAKING recently before a technical society on the current movement toward uniform lumber grading, a lumber expert said that a purchaser asking for one-inch dressed lumber "might think that an inch was an inch and demand as much. It would be his own mistake." The thickness of the boards actually furnished him would be somewhere in the neighborhood of ¾ in., the precise dimensions depending on the part of the country in which the lumber was sold. The expert stated that a house builder might have to fit together seven different thicknesses of board, all bought under the name of inch lumber.

This matter was taken up some months ago by a national conference of lumber men, which met at Washington, at the initiative of a government department, for the special purpose of eliminating the variation in thickness of inch lumber. The conference debated at great length whether ¾ in. or 1⅛ in. should be adopted as the standard thickness of "inch lumber," but it could not reach agreement.

It is a curious commentary on twentieth century civilization and on the elaborate machinery set up for establishing standard practice that it should be necessary to discuss whether a ¾-in. board should be called a one-inch board. But since there is such discussion, and since agreement cannot be reached, we make the radical suggestion that the name one-inch board or one-inch lumber be applied only to material one inch thick, and that boards ¾ in. thick be classed as ¾-in. lumber.

Just how the fictitious one-inch lumber came about is not entirely clear at this late date. Probably the explanation goes back to the early ages, when lumbering and sawmilling were crude backwoods arts. We may assume that in those days gang saws were spaced one inch in the clear, to produce one-inch rough boards provided the saw kerf did not turn out to be too wide. Dressed lumber made from the rough boards would naturally be about a quarter inch thinner, and as the principal stock dealt in was the rough stock, and the saws could not readily be changed to make odd thicknesses, the "1-in. dressed" lumber of ¾ in. thickness became an established article of the trade.

If conditions of pioneer days did not permit of sawing out 1⅛-in. or 1¼-in. boards to produce dressed lumber 1 in. thick, matters are rather different today. The art has changed, and every item of the picturesque train of machinery extending from the lumberjack's camps to the delivery side of the planer is vastly more adaptable than formerly. Today it is well within the range of sawmill technique regularly to produce rough stock in thicknesses that will yield dressed lumber of even dimensions. All the conditions that brought into being the former wrongly-named standard of thickness have been wiped out, but the traditional bad practice remains.

Must we continue to assemble groups of manufacturers to decide whether ¾ in. or 1⅛ in. shall be called an inch? Advancing civilization has progressively done away with wooden nutmegs, silk and wool made of substitutes, under-measure pound packages and quart bottles, and other deceptions that pleaded trade custom as an excess. It now has the opportunity to take another step forward and restore the inch to its proper place, by doing away with misbranded one-inch lumber.

Sentimental Rate-Making

MUCH water has flowed under the bridge since the just-decided grain rate case was submitted to the Interstate Commerce Commission. Then—only four months ago—wheat was quoted around $1.10; the day the case was decided (July 10) it reached $1.17 and it now is near $1.35. The farmer who was to be benefited by lowering his grain and grain products freight burden is being benefited by some other cause, just what cause need not be discussed, and the major part of the arguments in favor of grain rate reduction, as well as practically all of the contentions of the sizable minority of the commission who wished to lower rates, go by the board.

But the grain decision of the commission is important, because its main features have been misrepresented or misunderstood. Most of the comment adverse to the decision has condemned that section of the Esch-Cummins Act which fixes rates on the basis of a fair return to the railroads. It is assumed that this so-called guarantee of 5½ per cent acted to prevent the commission from reducing grain rates. But the decision itself says "Our conclusion is not based upon the sole ground that the carriers as a whole in the western district are not making a fair return. That is only one of the considerations. Still less do we consider that when the rates assailed are shown to be unreasonable the commission's hands are bound so tightly by . . . the act that we cannot grant any general reduction of the nature before us unless and until the interested carriers as a whole in their respective groups make a fair return."

In other words, the majority of the commission decided against lowering grain rates because in their opinion those rates were lower than the average rate, because the grains were not carrying more than their fair share of freight expense, and because the benefit to the farmers would be negligible compared to the damage to the railroad, unless the loss of revenue be made up by other increases, which would be unjust and nearly impossible, to boot, unless the formidable task of complete rate revision be attacked. The guaranteed 5½ per cent was only one element in the argument against lowering grain rates.

It is only fair to say that some of the minority contradicted the facts as to the relative burden that grain rates bear, but most of the minority took the position that the grain farmer was in a bad way and that everything should be done to help him. Whether or not the grains were paying too high was unimportant. The important thing was that the grain rates must be reduced. Such a reduction, it was admitted, would be but a drop in the bucket but regardless of its effect on the rest of industry it should be done on account of the moral effect such a reduction would have in saving the perishing basic industry of all. And then, before the decision is made public, something entirely removed from freight rates gives grain farming a boost that mounts it miles higher than anything short of free rail carriage could possibly do.

What is the moral? That rates and rate making are the most complicated things in the world and that they cannot be attacked piecemeal; but that the making of a rate for the purpose of the moral benefit it bestows on one languishing group out of the railroad's many users is warranted neither by economics or history.

Building a Pile Foundation for a Marsh-Land Factory

Heavy Concrete Mats and Pedestals Carried by 200,000 Timber Piles Sunk 10 to 50 Ft. Through Bog to Sand-Clay Bottom of Jersey Meadows Near Newark

By R. L. Hart
Construction Superintendent, Kearny Plant, Western Electric Co., Inc., Kearny, N. J.

UNUSUAL methods of developing a pile foundation in bog land have been employed in the construction of the new telephone manufacturing plant of the Western Electric Co. Altogether the factory units under construction require 38,000 piles and succeeding units will bring the total to 200,000. With the time limits set for building completion, the piledriving plant had to be got onto ground still to be reclaimed from the river or yet to be excavated to the grade of pile head elevation and had to begin driving before work which laid the piles bare for use could be done. The procedure is interesting since it has been notably successful.

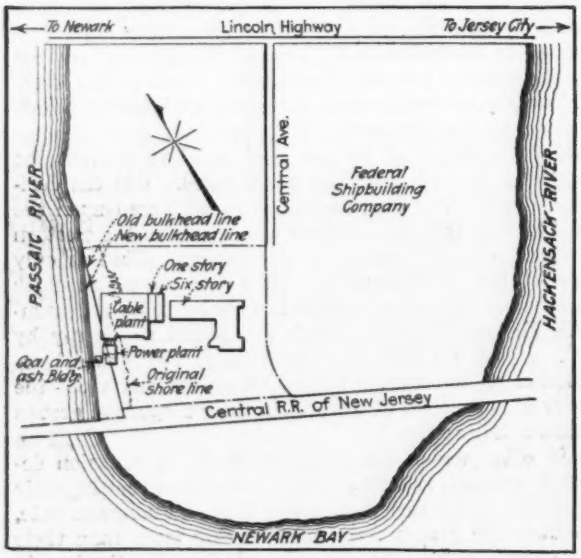


FIG. 1—LOCATION MAP OF NEW WESTERN ELECTRIC CO. PLANT

The plant is located in New Jersey just across the Hudson River from New York City, on the Passaic River a short distance north of its junction with the Hackensack River. The site comprises an area of about sixty acres located as shown by Fig. 1. It is the intention of the company ultimately to construct a plant which will employ about 30,000 people and, with the exception of the plant in Chicago, be the world's largest telephone manufacturing plant. At present there is under construction a bulkhead 1,725 ft. long; a power house with a capacity of generating 6,500 kw., but with provision for a future 20,000 kw.; a coal and ash-handling building; a one-story and basement cable plant 454 x 437 ft. and 756,000 sq.ft. of six-story building.

Shortly after acquiring the property the War Department approved a change in the bulkhead line to permit docking vessels along the entire water front of the property. Thus, when the layout, Fig. 1, was finally determined, part of the cable plant buildings and all of the power house were located in the water area back of the bulkhead line.

The entire site is bog, over a portion of which had been pumped from the river 2 to 3 ft. of river sand. From borings it was found that from 10 to 50 ft. below surface elevation there prevailed fine red sand and clay which would safely sustain a pile loading of from 20 to 30 tons. Therefore, all the foundations are on yellow pine piles varying from 10 ft. to 50 ft. in length, the average being about 35 ft. For the building and bulkhead now under construction there were required about 38,000 piles, while the remainder of the buildings will require about 160,000 piles.

If there had not been an urgent demand for the buildings, the logical procedure would have been to construct the bulkhead and complete the fill back of it to the shore line, thus permitting the construction of the buildings on filled ground. However, with need of the buildings paramount, it was necessary to start their construction before waiting for the bulkhead to be built.

The foundation, Fig. 3, for the cable plant buildings comprised 978 footings, with from 4 to 19 piles in a footing, making a total of 8,512 piles. The footings were carried from El. +2.5 to +6, where they supported a reinforced-concrete basement floor with a surface elevation of +6.5. As the building site was about one-third in water and the remainder was on marsh land, and also as it was desired to construct the bulkhead immediately in front simultaneously the question of methods of constructing footings arose. One was to build a cofferdam of wood sheetpiles completely around the water area of the buildings, which would inclose an area about 475 x 250 ft.; excavate the land area of the buildings, to El. +2.5; flood the inclosure and drive the piles from water piledrivers; unwater the dam, construct the concrete footings, backfill around them and

FIG. 2—PIER FORMS AND BACKFILLING FOR CABLE PLANT BUILDING

construct the concrete basement floor. While on the face this method appeared exceedingly expensive, it must be borne in mind that the surface soil was marsh mud. Another suggested method was to excavate the land area first, fill the water area and then drive the piles. This method was discarded, because, with the land area excavated, it was very doubtful whether the soil condition would permit moving the piledrivers over the excavated area and also because with the tidal condition along the river the area would be flooded at unusually high tides. The method finally adopted was to drive the piles first and follow with the excavation on the land and the fill in the water area. The land piles were driven to surface grade with land piledrivers and the water piles to water elevation with water drivers, the excavation and fill following shortly behind the piledrivers.

With the method adopted the greatest difficulty occurred in the water area where the filling around the piles, which projected from 5 to 15 ft. above hardpan through mud and water, moved the heads of the piles from their original position. A number of methods were tried to hold the piles in position, such as staylathing the piles in a footing one to another with timbers, Fig. 3, and bracing the footings to each other with a tieback to the shore, and lashing the piles and footings together with a wire cable tieback to the shore. All efforts to hold the piles in position failed and it was necessary to pull such piles into position as could be done without injury, with stump pullers, and where this failed to follow back of the filling, driving additional piles with land piledrivers in footings where the displacement of the heads of the piles caused eccentric loading.

In the original design it was thought it might be necessary to provide bottom wooden forms for the concrete footings and the basement floor slab, but the contractor in doing the excavation was able to save the river sand topping over a large part of the land area, and use it for backfilling around the piers, Fig. 2, thus eliminating the necessity of wooden forms. The basement slab concrete 6 in. thick was placed directly on the backfill in most cases. Where there was not sufficient sand for topping purposes and where the backfilled soil was in a muddy condition, 3 to 4 in. of concrete was poured over it and allowed to set for at least 24 hours before the reinforcing bars were placed and the slab concreted. This method of providing a form was found not only successful but much more economical than wooden forms which would have had to be left in place, and was employed not only for the floor slab form, but for the bottom of the footings.

The location of the power house entirely in the water

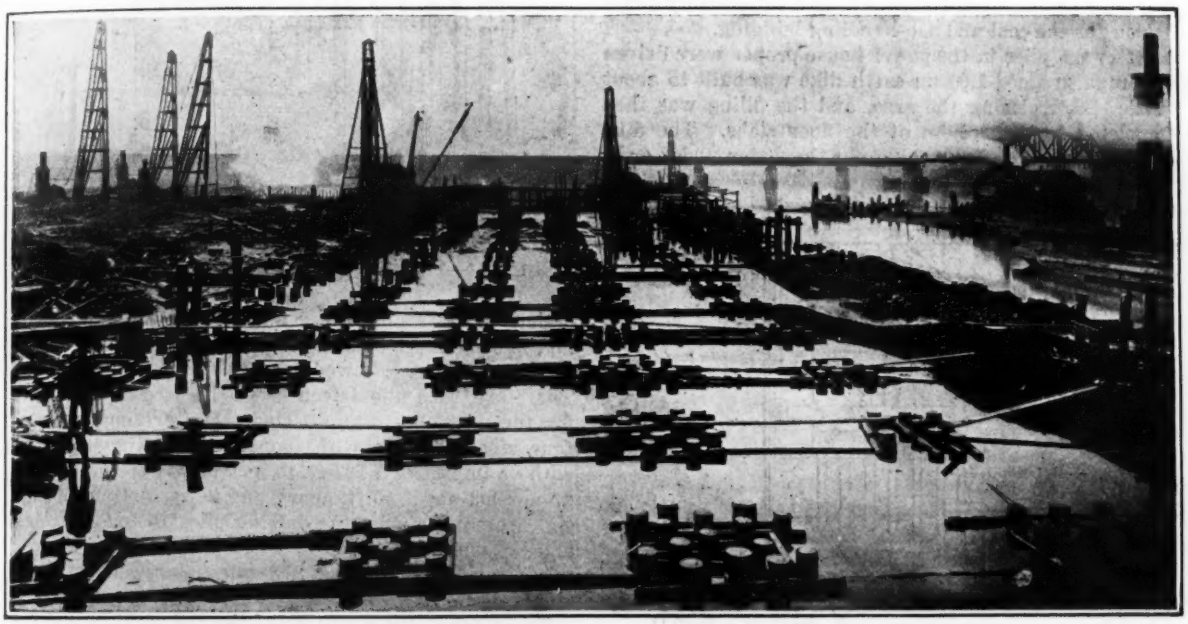


FIG. 3—CABLE-PLANT FOUNDATION PILES STAY-LATHED TO KEEP POSITION

area, with the intake and discharge tunnels, Fig. 4, for condensing water, projecting to the bulkhead line, the foundation piles of which had a cutoff elevation varying from —8.5 to —17.5 ft., and the coal and ash-handling building with a pile cutoff at El. —7.75 ft., necessitated the driving of all of the foundation piles with water piledrivers. For the low cutoff piles in the intake and discharge tunnels and in the coal and ash-handling buildings, water piledrivers, with steam hammers and telescopic leads, were used permitting the driving of the piles to exact cutoff grade. After driving the piles a cofferdam was constructed for the intake and discharge tunnels, which was from 20 to 35 ft. wide and 250 ft. long, composed of steel sheetpiles for the outshore portion and of 6 x 12-in. wooden sheetpiles for the inshore portion. Likewise for the coal and ash-handling buildings a cofferdam 54 x 73 ft. of steel sheetpiling was constructed. After unwatering the two cofferdams the foundation piles previously driven were checked and found to be as near to grade and alignment as it would have been physically possible to have driven them under ordinary circumstances at a surface cutoff elevation.

Previous to driving the piles the areas inclosed in the

cofferdams had been dredged to hardpan, but upon unwatering the intake and discharge tunnel cofferdam, it was found that about 3 ft. of fine silt had sloughed into the dredged area. The removal of the silt by excavation would have been a slow and expensive operation and as speed in construction was paramount a suggestion proposed by the contractor of starting a fill of medium size cobble at the inshore end of the cofferdam and displacing the silt in the direction of the pumps which were located at the outshore end was adopted and employed with success. The cobble fill was used not only to displace the mud but to prevent boiling in the bottom of the cofferdam. After the cobble was placed it was found to be so well graded in size as to reduce the voids to a minimum and permit its use for a bottom form for the floor slab of the tunnels in place of a wooden form. The same method was employed for obtaining a satisfactory foundation for the coal and ash-handling building.

After the piles in the power house proper were driven (average grade +1.0) an earth dike was built to about grade +9, inclosing the area, and the filling was then completed to the bottom of the floor slabs. The dike proved successful for keeping out the water under ordinary conditions, but on two occasions with a tide approximately +8 ft., the dikes gave way and the site was flooded.

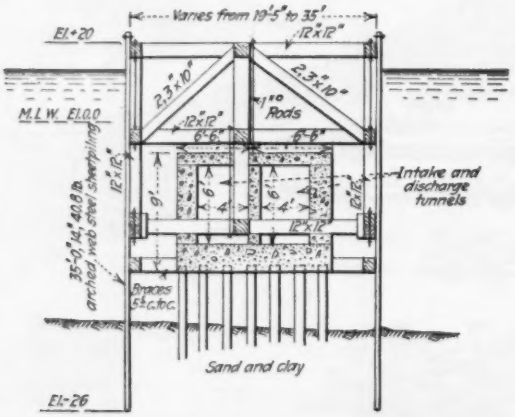


FIG. 4—CONDENSING WATER TUNNELS BUILT IN COFFERDAM

The construction of the foundation for the six-story buildings was attacked in a somewhat different manner from that of the cable plant building foundations. The deviation in methods was due to two primary reasons. One reason was that the difficulty experienced in excavating around the piles in the cable plant building indicated that, if the piles could be driven to cutoff grade (+2.5) instead of surface grade (approximately +7.0), the excavation could not only be expedited but could be done much more economically. The other reason was that only a small portion of the site of the buildings had been filled with a topping of river sand, therefore the soil was not satisfactory for backfilling and could not be used for supporting the basement floor slab.

The driving of the piles to cutoff elevation proved successful. While it was not possible to drive them all to exact cutoff grade, a large enough percentage were so driven as to permit excavating with cranes equipped with orangepeel buckets.

The driving of the piles to cutoff grade, of which there were about 17,000, was accomplished by using followers. In adopting the method much stricter supervision was required in determining the length and size of the piles to drive, as the requirements were that the piles must be driven by *Engineering-News* formula for steam hammers, to sustain a minimum load of 20 tons and that this loading should be determined at cutoff elevation. To increase the difficulty of selecting the correct size of the pile it was found from borings that the underlying stratum of clay and sand was very undulating, in some cases being as close to the surface as 15 ft., while 50 ft. away it would be 40 ft. from the surface. Therefore, each pile driven had to be used as a test pile for the next one to be selected. For driving the piles four steam drivers with hammers weighing 6,450 lb. with an impact of 7,727 ft.-lb. per blow were used, lined up abreast about 40 ft. apart, and it was not an unusual sight to see one machine driving piles 15 to 20 ft. long and the one adjacent 40 to 45 ft. long. With the four piledrivers as many as 275 piles were driven in a single day.

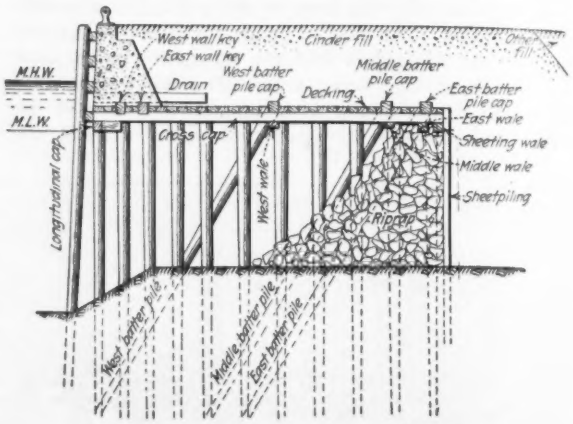


FIG. 5—TRANSVERSE SECTION OF BULKHEAD

To overcome the condition of the soil which would not permit placing the concrete basement slab on it, bottom wooden forms which required being left in place were adopted, the lumber for the forms being sawed from the pile tips which were necessarily left on hand from cutting the piles to varying lengths before driving.

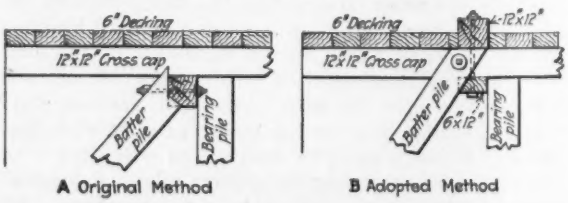


FIG. 6—PROPOSED AND ADOPTED METHODS OF BATTER PILE ATTACHMENT AT BULKHEAD

Before starting the bulkhead approximately 300,000 cu.yd. of river sand and mud were dredged from the river in order to obtain 20 ft. of water along the bulkhead. This dredging was performed by pumping the material to adjacent marsh land, with leads of 2,000 to 3,500 ft. The bulkhead, however, was designed for a future 30-ft. depth of water.

The bulkhead, Fig. 5, was constructed of yellow pine

piles 45 ft. long placed in bents 6 ft. apart with three batter piles to a bent; of 8 x 12-in. wooden sheetpiling, along the rear face, on the outshore side of which was placed riprap and along the inshore side cinders, and a 6 x 12-in. timber deck with a top elevation of +2.5. The batter piles were originally designed for a fish mouth connection to the longitudinal wales at El. —1.0, Fig. 6A, but due to the absence of extreme low tides permitting making the connections, the design was changed (Fig. 6B) so that the batter piles were cut off even with the tops of the pile caps, bolted to them and the adjacent bent pile, and capped with 12 x 12-in. wales placed at right angles and on top of the bent caps and bolted securely to them. Fig. 7 is a view of the bulkhead timbering.

Before starting construction on the concrete retaining

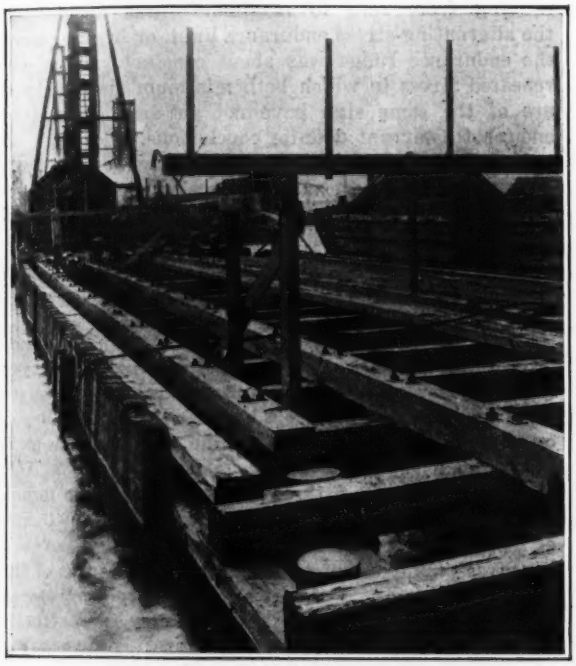


FIG. 7—REAR VIEW OF BULKHEAD TIMBERING

wall along the front of the bulkhead, investigation was made of a number of such concrete walls deposited in place to determine the extent to which they had been affected by sea water. The investigation disclosed that in all cases the walls examined had started to deteriorate. To eliminate the deterioration as much as possible a mixture of 1:1½:3 concrete was used so as to obtain maximum density and thus resist erosion. The concreting, which was placed by the novel medium of traveling belt conveyors, will be described in a subsequent article.

The construction of building foundations and the bulkhead was by Henry Steers, construction engineers, 17 Battery Place, New York. The design of the cable plant and six-story building was made by the engineering and architectural forces of the Western Electric Co., Inc., and McKenzie, Voorhees & Gmelin, Madison Ave., New York, consulting architects. The power house was designed by the J. G. White Engineering Corporation, 43 Exchange Place, New York, as consulting engineers, and Charles W. Staniford, 50 Church St., New York, acted as consulting engineer on the bulkhead and building foundation design and construction.

Trunk Sewer Advised from Lowell Down the Merrimack to the Sea

BASED on an investigation ordered by the State Legislature, the Massachusetts Department of Public Health has advised the construction of a trunk sewer from a point just below the mouth of Concord River in Lowell down the valley of the Merrimack River, a distance of 36.1 miles, to an outlet point into the Atlantic Ocean off the bar at the mouth of the Merrimack River. This plan is considered preferable to sewage-treatment works for various cities and towns or groups of cities and towns. The engineering studies were made under the direction of X. H. Goodenough, chief engineer, Massachusetts Department of Public Health. Based on pre-war prices the cost of the trunk sewer, tributaries and connections, a main pumping plant and one small subsidiary pumping station are estimated at about $10,000,000, compared with $8,400,000 for separate treatment works. The corresponding yearly charges are $173,500 and $360,000. The latter figure, however, was reached after allowing $110,000 a year for grease recovered from the wool scouring wastes of Lawrence and sold at an average price of 1½c. per pound.

The proposed trunk sewer would serve the cities of Lowell, Lawrence, Haverhill and Newburyport, and thirteen towns in addition. The combined population of the cities and towns by the census of 1920 was 344,407. The average estimated volume of sewage and manufacturing wastes in the Merrimack valley requiring disposal through a trunk sewer in the year 1923 is estimated at about 41 m.g.d. average dry-weather flow and 70 m.g.d. average maximum rate of flow. For 1965 the corresponding estimated figures are 84 and 157 m.g.d. The estimates assume that a considerable amount of the less badly polluted industrial wastes will be discharged directly into the Merrimack River and its tributaries without treatment.

The proposed trunk sewer would be equivalent to one with a diameter of about 6½ ft. at its upper end, where the capacity would be about 51 m.g.d. with the sewer flowing three-quarters full. The pumping station would be located in Amesbury, nearly opposite the mouth of the Artichoke River. It would deliver the sewage, ultimately, through two 60-in. force mains which would empty into a sewer with a diameter of about 11 ft. and a capacity of 119 m.g.d. The sewage of Newburyport would be pumped to the lower portion of the trunk sewer. The estimates for disposal by separate communities and groups of places include eleven pumping stations and fourteen sewage-treatment works.

The action of the legislature in ordering the investigation was the result of more or less continuous agitation for the past fifteen to twenty years by the inhabitants of the Merrimack River valley, chiefly at Lawrence, Haverhill and below. It is thought that the estimated cost of $10,000,000 on the basis of pre-war prices may prevent immediate action on the report.

N. Y. Subway Carries Billion Passengers

The number of passengers carried by the Interborough Rapid Transit Company in New York City in the fiscal year ended June 30, 1924, was 1,074,343,243, compared with 1,025,175,131 in the preceding year, an increase of about 4.8 per cent, according to figures given in the company's annual report.

Further Endurance Tests—Third Illinois Report

Steel Strengthened by Repeated Stress—Axial and Shearing Endurance Lower Than Bending Endurance

CONTINUED work in the investigation of fatigue and endurance phenomena in steel and other metals at the University of Illinois during the past year developed a number of important conclusions additional to those previously reported (see *Engineering News-Record*, Jan. 12, 1922, p. 76, and Aug. 23, 1923, p. 308). The recent work is summarized in Bulletin 142 of the Illinois Engineering Experiment Station, by H. F. Moore and T. M. Jasper.

Existence of an endurance limit for wrought ferrous metals is strongly confirmed by the additional evidence brought out in the recent test work. This applies to reversed bending, reversed axial stress, reversed shearing stress, and incomplete reversal of the same kinds of stress. In all instances a value of stress can be located below which an indefinitely large number of repetitions of stress may be applied without causing fracture.

Steel Strengthened by Stress Repetition—In addition, a series of endurance tests made on specimens that had been subjected to several million cycles of stress somewhat below the original endurance limit showed that this moderate stress not only failed to injure the material, but actually strengthened it. The endurance limit after the first series of stress repetitions was higher than before. This strengthening effect was most marked for steels which are improved in static strength by cold working.

Overstress Injures Material—Applying a few cycles of alternating stress above the original endurance limit of steel lowers the endurance limit. Some of the injury to the material which this effect indicates may be repaired by polishing the surface of the specimen or by applying repeated stress *below* the endurance limit.

Axial Endurance Lower Than Bending—Most of the tests heretofore reported have been made in reversed bending (rotating cantilever specimen). During the past year a large series of tests in reversed axial stress was carried out. Their results show that the endurance limit for axial stress reversal is only about two-thirds the endurance limit in reversed bending. In an extensive series of comparative tests the ratios of axial endurance limit to bending endurance limit ranged generally from 0.61 to 0.70, with a few values as low as 0.56 and 0.58. The average of all the ratios found was 0.64.

At least part of this reduction in strength is believed by Professors Moore and Jasper to be due to the uneven stress distribution in the short specimens used in the axial stress testing machine. However, they recommend that for the present the axial-stress endurance limit of steels be considered as only 60 per cent of the bending endurance limit.

Transverse Endurance—In tests made on specimens cut across the direction of rolling of the steel, both the static tensile strength and the endurance limit were found to be lower than for longitudinal specimens, and about in the same ratio (0.70 to 0.90 and higher, depending upon the steel). The strength ratio of the transverse specimens was frequently improved by heat treatment.

Soft Steel Improved by Quenching—Steel of very low carbon, 0.02 per cent (ingot iron), was greatly improved in endurance as well as in static strength by water quenching; the endurance was frequently raised 20 per cent.

Shearing Endurance—Under reversed shearing stress, as applied in a reversed torsion machine, the endurance limit was only about 53 per cent of the endurance limit in reversed bending.

Incomplete Reversal—A higher endurance limit was found when the stress was not fully reversed. When the minimum stress was zero, the endurance limit was 50 per cent greater than when the minimum stress was equal (but opposite) to the maximum stress. This was found to be the case both in reversed bending and in reversed axial stress. In the case of shearing stress, however, the repeated-stress endurance limit (stress ranging from zero to maximum) was about twice the alternating-stress endurance limit, or in other words the endurance range was about constant. Tests with repeated stress in which both minimum and maximum are of the same sign have not yet been carried far enough to warrant definite conclusions.

Non-Ferrous Metals—No dependable endurance limits have yet been discovered for annealed copper, annealed brass, annealed bronze, and hot-rolled monel metal. Tests have been carried to more than 100,000,000 cycles without revealing a stress limit below which fracture does not occur.

A Theory of Fatigue—In connection with the report of their recent work, Professors Moore and Jasper present a theory of fatigue failure in steel which departs from the belief hitherto held by some that slip occurring on slip planes within the crystalline grains of the metal is the starting point of the fatigue fracture. They advance the view that the failure starts at some minute region of localized excessive stress, where a small fiber of metal is torn apart. In the early stressing, even at low stress, many minute internal tears or fissures of this kind are believed to be formed. In this process, internal stresses are relieved, and the metal may thereafter be better able to resist stress than before; however, from one or more of the minute tears a larger fracture may grow. While these fractures are forming there is also a strengthening effect upon the metal going on, as amply demonstrated by the tests. This is believed to be partly a readjustment of the grains and partly a relief of internal stress. Thus, both destructive and conservative processes are going on in the stress repetition. When the stress is above a certain definite limit, the destructive effects overbalance the strengthening effect, and some of the small fissures in the metal extend to the point of complete fracture.

Short-Time Tests—The rise-of-temperature test to determine the endurance limit and the method of determining the endurance limit from the load-deflection diagram for a rotating beam are considered to give closely correct results for wrought ferrous metal. They are not yet shown to be dependable in the case of cast metal or of non-ferrous metal. The points determined by these two short-time tests, however, are believed to mark the beginning of slip within the grains of the metal rather than the beginning of fatigue fracture, and it is considered to be more or less fortuitous that the two phenomena occur at nearly the same stress limit.

Official Report on Collapse of Gleno Dam

Investigators Declare Design of Base Inadequate and Whole Structure Defective—Failure of Base Responsible

ENGINEERING experts appointed by the prosecuting attorney of Bergamo, in northern Italy, to report on the causes and conditions of the collapse on Dec. 1, 1923, of the Gleno storage dam located just above the village of Vilminore, recently presented their report. It has just been published in the government journal of the Ministry of Public Works, "Annali di Lavori Publlici." The experts were Prof. Gaetano Ganassini and Prof. Arturo Danusso. They made surveys of the dam, examined the ruins, heard witnesses, studied the plans of the designers and compared them with the actual structure, tested the material of the dam and analyzed the design for adequacy. Their report is supplemented by a laboratory report on the strength of the concrete of the dam and the report of a geologist on the suitability of the site for construction of a dam and the possibility of earthquake action as a contributory factor in bringing about the failure. The net result of the study is to show that the geological conditions were entirely satisfactory for a dam, that no earthquake motion is involved, and that the dam was poorly designed and very badly built. Failure was due wholly to inherent weakness of the design and extremely bad execution of the construction work.

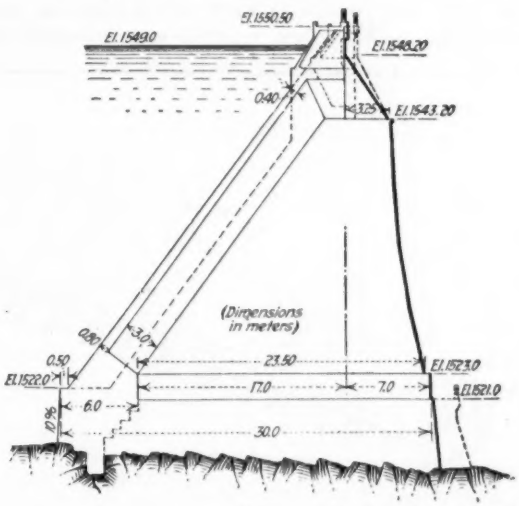
The fundamental cause of the failure, according to the expert report, lay in the weakness of the stone-masonry base portion of the dam, a gravity mass which occupied the central part of the gorge and on which the multiple arch superstructure rested. The size and strength of this masonry base was not sufficient. It was built on a rock surface sloping downstream, which surface was not trenched or stepped off; only a few steel anchor rods held the masonry to the rock. The lime mortar used in laying up the masonry was weak and did not set up well. The dam leaked from the start, and this leakage steadily increased until 4 or 5 sec.-ft. of water was flowing downstream from the dam in the period just before the collapse.

No determinable immediate cause of the collapse could be discovered by the experts. They do not consider it possible that initial failure occurred in the concrete superstructure, in spite of the fact that the concrete was of very poor quality. They conclude that collapse started as the result of settlement of the base masonry, which set up abnormal stress in the superstructure so that this failed in its weakest point, one pier, the eleventh from the westerly end of the dam, and the two adjoining arches failing first.

Descriptions of the dam and its failure appeared in *Engineering News-Record*, Jan. 31, 1924, p. 182, and March 20, 1924, p. 486. The facts and conclusions there recounted are confirmed by the report of the experts. The following summary of the report therefore repeats some facts already given.

General Character of Dam—The dam was built at the lower end of a basin just below the crest of the mountains. The downstream rim of the basin, on which the dam was built, was cut through by a deep V-shaped gorge; in this gorge the dam reached the height of 164 ft. (lowest contour of stream bed 1,500 m., roadway on crest 1,550.50 m.). Elsewhere its greatest height was 95 ft. Its total length was 721 ft. In plan the central portion, 236 ft. long, was curved upstream on a radius of 317 ft. The straight flanking portions were tangent to the curve of the central part, that on the right bank being 328 ft. long and that on the left bank 157 ft. The curved portion practically coincided with the top width of the stream gorge.

In the gorge the lower half of the structure consisted of a mass of masonry filling the gorge like a plug, while the upper part was a cellular concrete structure with sloping deck of slope 4 on 3, composed of semi-circular arches spanning 19.7 ft. in the clear between 6½-ft. piers. This concrete structure continued across the sides of the valley, resting directly on bedrock except



From report of official investigators

FIG. 1—TYPICAL CROSS-SECTION OF GLENO DAM

Rock surface in deepest part of valley sloped downstream and was not stepped off. Dotted lines at crest show change from design plans. Added section shown dotted at toe represents contemplated addition of masonry, necessary because by error the upper part of the dam was built 6 or 7 ft. too far downstream. Only part of this addition had been built at time of collapse. Most of the footwalk was carried across the central gorge on steel brackets.

over the masonry plug. The piers at the junction of curved and straight parts of dam were of double the normal thickness. Other features of the cross-section can be seen from Fig. 1, although the height of the base and the bonding between base and rock there shown are not typical of the actual structure.

Originally the company and its consulting engineer planned to build a gravity dam, with an arched closure of the gorge in the lower portion, the experts state. After various changes of idea these plans were submitted to the government, and a franchise was granted. Work was under way according to these plans, and part of the closure masonry had been built, when it was decided to replace the upper part of the massive gravity section by multiple-arch construction, retaining the idea of a massive masonry base plug. No great change in this plug was required by the change, as the original plans contemplated using different profiles for base and super-structure masonry. However, as some of the superstructure masonry work had been started, it was necessary to take down some masonry on the right bank and alter other parts of the masonry to form pier bases; also, in order to increase the thickness of the base plug, a certain amount of

backing-up concrete was added on the upstream side. The plug was capped with a 6-ft. slab of concrete.

Design—The design of the reinforced-concrete superstructure was made for approximately 500 lb. per sq.in. compression in the concrete and 20,000 lb. tension in the steel. The reinforcement of the deck arches was to be tied to longitudinal rods in the piers, which latter in turn were to be tied together by horizontal reinforced-concrete belt courses in the piers, spaced 16 ft. apart. The portions of the piers between these belts were to be of leaner mix of concrete. As to the masonry base plug, no stability calculations or stress analyses appear to have been made. Those subsequently made by the engineering experts show alarming deficiency in stability.

In this connection the foundation profile is of importance. The rock bottom is hard, sound material, not fissured; and with surface rounded and smoothed by

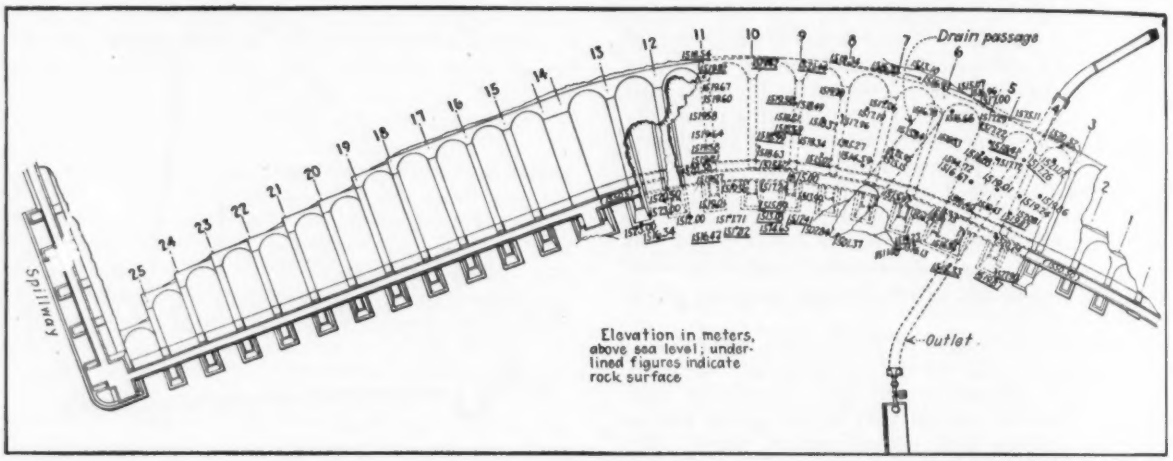


FIG. 2—PLAN OF BREAK IN DAM

From report of official investigators.

glacial and water action. At the site of the dam, particularly in the deep gorge section, the rock surface slopes sharply downtsream, one profile being illustrated in the section shown in Fig. 3 (pier 7). Such downstream slope prevailed over about two-thirds the width of the gorge, and the plug masonry was simply built on the slope. Little work was spent on preparing the rock foundation. Some nominal attempts were made at roughening the surface by blasting out shallow pits here and there, said to range from 12 to 30 in. deep, but all the evidence indicates that the rock was nowhere stepped off, and only a very small amount of trenching to form toe walls was done.

Material and Construction—The specifications required the masonry to be laid in cement mortar, and the superstructure to be built of cement-lime concrete, of two different mixes: the arches and reinforced belt courses in the piers, 150 kg. cement and 100 kg. lime per cu.m. (about 1:3:6), remainder of piers, 100 kg. cement and 100 kg. lime per cu.m. (about 1:3½:7) and in addition could have 50 per cent boulders inserted in the concrete. In the actual execution, however, no lime was used in the concrete except in a few pier bases, and the amount of cement used was 200 to 250 kg. per cu.m. in the first case and 150 to 200 kg. in the second. Most of the base masonry was laid in straight lime mortar. The evidence is that some few parts were laid in cement mortar or in cement lime mortar, and that a capping layer of concrete 6 ft. thick was constructed over the top of the rubble masonry.

Examination of the ruins indicates that the mortar in the masonry was not thoroughly hardened, although it was several years old at the time of examination. The superstructure was also of wretchedly deficient construction. The manner of building the piers resulted in their having an average cement content of not exceeding 100 kg. per cu.m., the experts state. The arches were of somewhat richer mixture. In constructing the piers (except the reinforced belt courses) it was customary to use two cars of stone (boulders when available, gravel in certain stages of the work) to two cars of concrete; the concrete was placed against the forms and the stone dumped to form the interior of the pier. The concrete itself was made generally from poorly washed sand and gravel, but at certain times, when the sand pits were flooded, from gravel alone. Examination of the concrete in the broken piers shows large parts of the material to consist of coarse aggregate bonded together with a very little neat cement.

Specimens of the masonry base for testing could not be obtained. Four specimens of concrete cut from different parts of the structure and tested in the laboratory of the Milan Technical College in the form of 5x5- to 16x16-in. cubes showed crushing strengths ranging from 640 to 1,500 lb. per sq.in. in compression. However, in spite of the fact that the superstructure concrete was very poor, the experts conclude that the quality of the plug masonry was even lower.

Leakage through the dam was noticed from an early stage of its construction. The lower part of the dam was built in 1921, while the superstructure was not completed until the fall of 1923. Even in 1921 there was noticeable leakage, both through the base masonry and between the base and the underlying rock. While the pool was being raised during the construction of the superstructure, in June, 1923, the owner, in view of the increasing leakage, drew down the pool to the bottom of the superstructure, but apparently nothing was done to stop the leaks. It was testified that the leakage increased steadily during the month or more that the dam stored water up to the full pool level (October and November, 1923) and that in the last few days before the break the leakage near the bottom of the plug

masonry and between the rock and the masonry increased decidedly. Various estimates of the total leakage ranged up to about 4½ cu.ft. per second; it was possible to develop 500 kw. from the leakage flow at a power plant which is situated some distance below the dam.

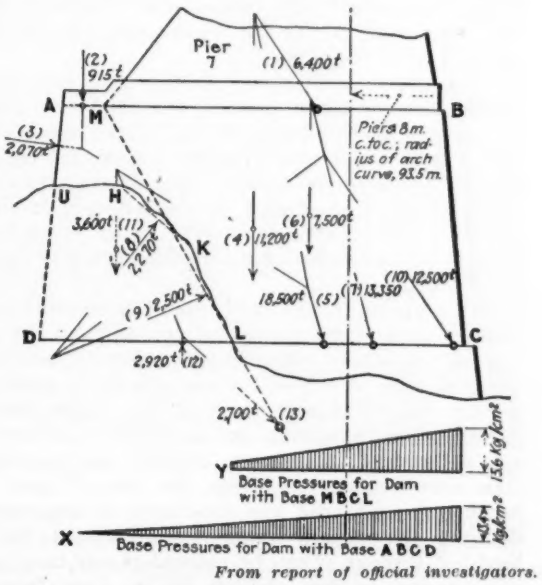
Failure of Dam—Except for the increase of leakage, no symptom of distress was visible in the structure before the break. Early on the morning of Dec. 1, about 6:30, the watchman at the dam was instructed by telephone to open the discharge gate so as to increase the water flow at the power plant. While returning across the footwalk running along the base of the superstructure and on top of the masonry plug, when near pier 8 he felt a movement or disturbance. A moment later some stones fell from above and dropped into the pools of water between the piers. Then he noticed that a concrete pipe drain which carried off leakage water was cracked. He was on his way to examine this break more closely when he heard further noise, more stones falling, and on looking up saw a dark vertical mark in the front face of pier 11. Going there and lighting a match to examine the mark, he noticed that it was a crack, which seemed to be extending and widening, and thereupon he started to run to the telephone to report the matter. Almost immediately afterward large pieces of concrete fell, and looking back he saw the cracked pier break, splitting in two; this was followed immediately by the failure of the two adjoining arches, the surging out of water, and then the progressive crumbling of the remainder of the central part of the dam.

As already reported, the outrush of water from the basin down the steep valley below caused vast damage and great loss of life, several hundred people being killed. The superstructure of the dam was completely torn out from pier 3 to pier 12 and the downstream part of the arch between pier 12 and pier 13 was torn away. Pier 13 was thoroughly shattered, showing a large number of diagonal cracks sloping downstream (pictured in *Engineering News-Record*, March 20, p. 488), and the upper part of the pier was displaced to the right. There was a large horizontal crack in the base of the dam extending through the central part a short distance into the right-hand straight part of the dam. The masonry of the base plug was deeply eroded, so that in places the foundation rock was bared. Of the downstream face of the masonry only a small part on the left bank remained. The lower end of the outlet passage was broken away on a general downstream slope like the rest of the masonry.

Stability of Base—The stress conditions in the base masonry are indicated by the pressure-line analysis shown (Fig. 3) for pier 7, typical of a number of the sections through the central part of the dam. In this figure the resultant pressure line (5) represents the location of the pressure line if the dam is considered to have an integral base ABCD. If the left-hand part of this section AMLD is considered to be removed, so that the base of the dam consists only of the area MBCL, the resultant moves over to position (7). If in addition hydrostatic pressure is assumed acting along the rock surface UHKL, the resultant shifts over to position (10) close to the toe of the dam. In some of the other sections in the central part of the dam, the static conditions are even worse.

The evident inadequacy of design of the base, even apart from its defective material, was aggravated in construction by faulty location of the structure, which resulted in making the curve of the superstructure not concentric with the curve of the base, so that near the middle of the curve the superstructure was about 2 m. downtream of its intended position. The section in Fig. 2 shows the superstructure in the position as built, whereas the design intended the base to project something more than 2 m. downstream of the toe of the pier pedestals, allowing room for a footwalk. This footwalk actually had to be carried on brackets attached to the downstream face of the masonry.

Conclusions—The experts conclude that the base masonry was on the point of failure at all times after the filling of the reservoir. They believe that the continued leakage through the masonry progressively weakened it and tended to induce settlement. The condition was the more threatening because the base



From report of official investigators.

FIG. 3—BASE-PRESSURE ANALYSIS AT PIER 7

plug could not act as an arch between the rock sides of the gorge both because of the failure to step the rock so as to form abutments for such an arch and because of the virtual cutting in half of the masonry by the drain tunnel, which was 10 ft. wide by more than 30 ft. high.

In view of the fact that the first signs of failure appeared in one of the piers, they considered whether a local defect in the superstructure might have originated the failure. They conclude, however, that this could not be the case, in view of the survival of the other piers and in view of the fact that the dam held its full head of water for more than a month. A gradual failure must have taken place under these conditions, and this it is decided almost certainly occurred in the base masonry.

The fundamental cause of the collapse, they finally state, was the weakness of the supporting masonry in the central part of the dam. Its dimensions and its strength were not sufficient for the service to be performed.

Second Water Purification Works for Oklahoma City

Sixteen-Year Old Filtration Plant Gives Way to New Combined Clarification Softening, Double Aeration and Carbonization Plant

FLEXIBILITY of treatment, secondary aeration to eliminate tastes and odors, mechanical agitation in a secondary mixing chamber and final treatment of the effluent with compressed and scrubbed CO_2 obtained from the boiler flue gas are features of the new 16-m.g.d. water purification plant recently put into operation at Oklahoma City. The old filtration plant, built in 1906 and enlarged in 1908, was antiquated and almost beyond redemption. Furthermore, it was incapable of satisfactory extension because of the location of other structures. Only the old coagulation basins could be utilized economically in the new plant, which is so laid out that it can be enlarged by the addition of similar units to give an ultimate capacity of at least three times its present capacity. This expense was considered necessary on account of the extremely rapid growth of the city.

Water is derived from a storage reservoir, on the North Canadian River, which covers 1,700 acres and has an average depth of only 8½ ft. Large areas of the reservoir are shallow and support a luxuriant vegetable growth. This condition materially affected the design of the filtration plant since it is called upon to remove tastes and odors and coagulate a water which is frequently seriously affected by organic matter in colloidal suspension.

In the design loss of head was of paramount importance since the size of the supply conduit and the elevation of the supply reservoir were already determined and had been designed for the old plant which had neither mixing chamber nor aerator. The elevation of the pumps supplying the distribution system was also determined. Large-size conduits and careful design were necessary to keep the loss of head to a minimum. Lost head was considered so important an item that the primary aerator was designed so that the head lost through it can be reduced at any time by removing one or two sections 20 in. long from the top of each riser.

As the water leaves the storage reservoir it passes through a motor-operated traveling screen with ⅜-in. clear openings, installed principally to remove fish which at certain times of the year enter the conduit in large schools and would constitute a serious nuisance unless removed. The water flows through a 42-in. reinforced-concrete conduit seven miles to the filtration plant by gravity and is delivered at sufficient residual head to pass it through the plant without pumping under normal operating conditions. An overflow weir in a concrete tower cares for any excess water flowing through the conduit line. From the conduit the water passes through the following structures in the order named: Primary aerator, primary mixing chamber, coagulation basins, secondary mixing chamber, filters, 1-m.g. clear well, secondary aerator (at certain seasons of the year) and 2.5-m.g. clear well.

Equipment—The primary aerator is a shallow concrete basin, 65x52 ft. in plan, supported on beams and columns. The water is distributed through a concrete manifold system beneath the aerator floor to 48 6-in. cast-iron riser pipes extending 5½ ft. above the aerator floor. Each riser pipe supports three cast-iron pans, and the water falls from the top of the riser pipe successively over these pans and to the floor of the aerator. The water is collected again in a depressed bay in one corner of the structure. A walkway was built around the aerator to make it easily accessible both for workmen and for the public.

The primary mixing chamber is a reinforced-concrete tank 52x41 ft. in plan and 16½ ft. deep, divided into five chambers 10 ft. wide by concrete partition walls. Cypress over-and-under baffles are spaced 5 ft. c. to c. and serve to give the water a high velocity. The baffles are so arranged that if a lower velocity is desired two channels can be operated in parallel. The walls of this structure and the aerator were flashed with gunite above the water line to prevent deterioration of the concrete as a result of frost action.

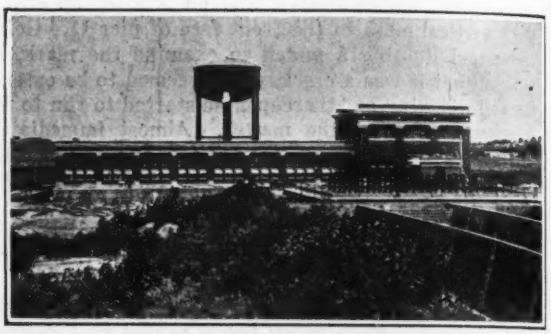


FIG. 1—OKLAHOMA WATER PURIFICATION PLANT
Looking over coagulating basins at right, primary aerators in central position of picture in front of headhouse. The one-story building at left houses the filter operating floor.

An interesting detail of design was the method of carrying the pressure of water on the walls of the basin. Vertical steel carries the stresses to the top and bottom of the wall. At the top of the basin a beam was designed to lie on its side and was supported by tierods encased in concrete across the basin. This beam serves as a walkway for employees and visitors.

Four coagulation basins, in use a number of years, were utilized in the new plant to operate in parallel. Two of these basins were 50x190 ft. and 12 ft. deep and the other two were 40x190 ft. and 12 ft. deep, each with a central baffle. The walls of these basins were badly disintegrated above the water line and were repaired with cement guns. The baffles were rearranged so that the inlet and outlet could be changed from the south to the north end of the basins.

The secondary mixing chamber is a reinforced-concrete basin 56x28 ft. and 18½ ft. deep. As the water enters this basin it is mixed very rapidly by three motor-driven agitators or circulators. The motors for the agitators are located in a small brick building on top of the basin. The remainder of this basin serves as a reaction chamber in which practically no sedimentation is expected to occur.

Eight rapid sand filter units have a normal rated capacity of 2 m.g.d. each although it is expected that rates can be maintained successfully at 30 per cent overload. Each filter is divided into two parts by a centra

wash-water gullet beneath which is located the main filtered water collector. Lateral steel wash-water troughs are so spaced that there is 4 ft. 7½ in. in the clear between them. The filter bed consists of 16 in. of graded gravel and 26 in. of filter sand of an average effective size of 0.37 mm. and a uniformity coefficient of approximately 1.65.

The lateral underdrains consist of 3-in. standard cast-iron pipe, flanged on one end and threaded on the other. They are spaced 12 in. c. to c. and drilled on the bottom side with ⅛-in. holes on 6½-in. centers. The gravel between these laterals was placed by hand with the greatest of care to secure a uniform distribution of wash-water.

The pipe gallery is 15 ft. wide and is exceptionally open. A concrete raw-water flume 6 ft. wide and 2 ft. deep is hung below the beams of the operating floor. The top of a 4x4½-ft. concrete filtered water conduit serves as the central part of the gallery floor. A 24-in. cast-iron sewer is located on each side of the filtered-water conduit beneath the floor. The 20-in. cast-iron wash-water line is directly under the raw-water conduit. Only one fitting on each filter is not a standard cast-

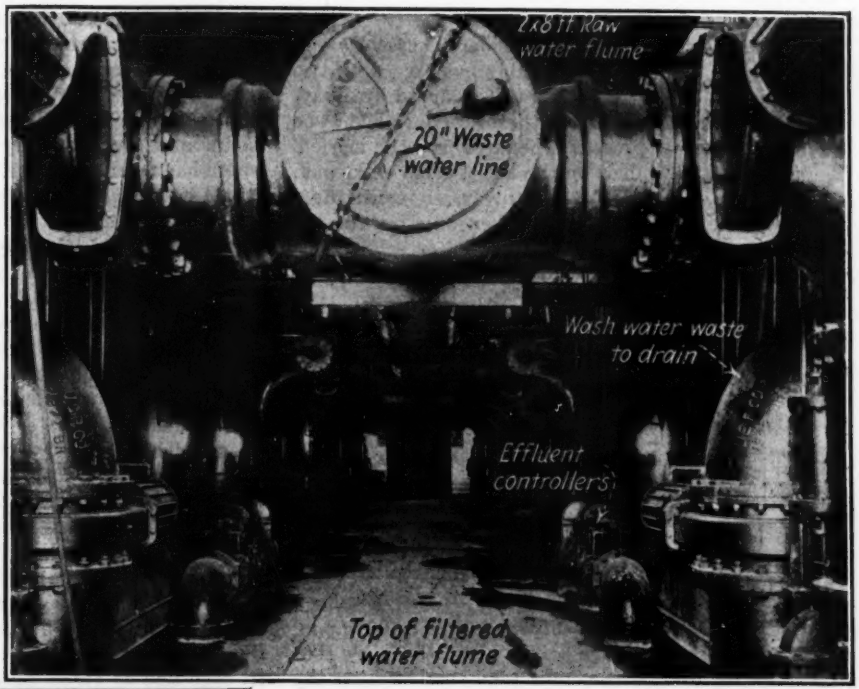


FIG. 3—PIPE GALLERY DESIGNED FOR ACCESSIBILITY

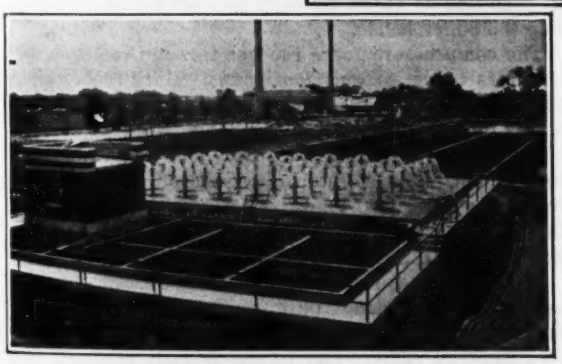


FIG. 2—FOUR-FALL PAN AERATORS IN OPERATION
Secondary mixing chamber with house for agitator motor. Top section of aerator discharge can be removed when head is low. Coagulant basins and clear wells in front of pumping station.

ing. All the hydraulic valves are installed parallel to the walls, either in a vertical or horizontal position where they can be packed from the floor. The effluent controllers are of the diaphragm type, so located that they can be readily repaired from the floor of the gallery. Natural light is admitted from both ends of the gallery and electric lights are located on the side walls.

Indicating-recording loss-of-head gages and turbidimeters of the Baltimore type are mounted on the tables. The combination of pink Tennessee marble tables and black doors and mountings gives an attractive appearance.

The head house adjoins the filter room and is 48 ft. square inside and like the other buildings is of rough texture brick trimmed with Bedford stone. The basement, which is one-half above ground, houses the motor-driven centrifugal unit which pumps filtered water to the wash-water tanks and two motor-driven compressors for compressing carbon-dioxide gas. Each compressor has a capacity of 210 cu.ft. of free gas per minute against a head of 5 lb. and is driven by a variable-speed motor. The basement is also used for the storage of a reserve supply of chemicals and as a dressing-room for laborers. The wash-water meter, carbon-dioxide qualitative and quantitative meters, clear well and raw-water gages are located in a lobby on the main floor opening into the filter room. This floor also houses an office for the superintendent, a dressing-room for operators, a glass-enclosed chlorine room and a laboratory equipped to handle any kind of chemical and bacteriological work that may arise. On the mezzanine floor of the lobby are four dry-feed chemical machines, with a provision for three additional units. These machines are of a new type developed for this plant. The chemical is moved forward by two Archimedean screws, either or both of which may be used. The speed of the screws is controlled by changing the location of the driving wheel on a motor-driven friction disk. The machine is calibrated in grains per gallon for different rates of filtration. The discharge is located at such an elevation that the chemicals flow to the points of application by gravity through 3-in. cast-iron pipe.

The third floor of the head house is for chemical storage. All chemicals are purchased in sacks and are unloaded from the cars to an incline running to the basement of the head house. The sacks are piled on wooden boats and are carried to the third floor by a hydraulic elevator. Here a truck is run under the boats and they are hauled to storage. The chemicals remain

on these boats until they are hauled to the hoppers above the chemical feed machines.

A 1-m.g. covered clear well 120x120 ft. and 10½ ft. deep is of the "dishpan" type. The shallow depth was dictated by the fact that the bottom of the well is only 1 ft. above the top of a bed of quicksand many feet deep. It was not considered practical, therefore, to use what is ordinarily the most economical depth for basins of this type. The roof is 4 in. thick, supported on beams and columns.

A secondary aerator was considered essential at certain seasons of the year, probably not exceeding two months, to remove the tastes and odors caused by decaying vegetable matter. One was therefore designed to be used as a finishing process whenever it was needed. When it is used the valves on the outlet from the 1-m.g. clear well are closed. Two motor-driven centrifugal pumps, in a concrete pump chamber adjacent to the

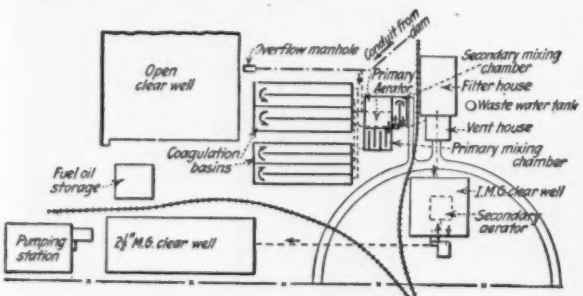


FIG. 4—GENERAL ARRANGEMENT OF UNITS IN NEW PLANT

clear well, having capacities of 5,600 and 8,400 g.p.m. against a head of 50 ft., are driven respectively by 100- and 150-hp. motors. The pumps take suction from the 1-m.g. clear well and force the water through a cast-iron pipe loop which rests on the bottom of the clear well. Four-inch galvanized risers spaced about 2 ft. c. to c. carry the water through the roof of the clear well to 81 3-in. turbine center-jet bronze nozzles. The water falls to the roof of the clear well, which is surrounded by a low concrete wall, and flows to a collecting manhole located on the outlet to the clear well just beyond the closed valve.

A second clear well of 2½-m.g. capacity and of practically the same design as the smaller one, 304x112 ft. and 10½ ft. deep, was constructed close to the pumping station so as to make short suction lines for the various service pumps. The top of this basin is to be used for four public tennis courts.

Additional filtered water storage is provided by a connection to the old open 10-m.g. filtered-water basin. It was planned to use this as an emergency reserve, but it is actually being used at the present time in regular operation.

Wash-water storage is provided by a 100,000-gal. steel tank of special shallow design, set on a 45-ft. steel tower. The tank is kept full by a 700-g.p.m. motor-driven pump, located in the basement of the head house. An 8-in. emergency connection with the distribution system gives an independent method of filling the tank.

A 20-in. wash-water controller, consisting principally of a Venturi meter and a diaphragm-operated butterfly valve, can be set at the desired rate of washing and locked. Thus the plant superintendent may determine with certainty the rate of wash to be used for any rate up to a vertical rise of 36 in. per minute. Such a device will prevent the disturbance of the gravel layers and the destruction of the filter bottom.

Chemical Treatment—The plant was designed to soften partially as well as to clarify and to purify the water. Flexibility of operation was considered a prime requisite. As occasion demands, the piping is so arranged that any one or more units may be bypassed.

Hydrated lime and soda ash from the machines in the head house can be applied at the entrance to the primary mixing chamber or at various points in this chamber. Iron or aluminum sulphate can be applied to the water at various points in the primary mixing chamber or in the conduit line between the coagulation basins and the secondary mixing chamber. After the water has been treated at this latter point, it is rapidly mixed by passing through a Venturi tube before reaching the agitators.

Carbonization—A study of the water to be treated indicated that under normal conditions the best results could be obtained most economically by treating the water with an excess of lime as it entered the primary mixing chamber. This treatment would reduce the total hardness approximately one-half and would remove nearly all the magnesium. If carbon-dioxide gas were added to the water leaving the coagulation basins, the residual causticity could be neutralized; if a small dose of alum were then added and thoroughly mixed with the water in the secondary mixing chamber, a pure, sparkling and comparatively soft effluent could be obtained from the filters. Stack gases from the breeching above the boilers in the power house are drawn through duplicate scrubbers by the motor-driven compressors located in the basement of the head house, through a 6-in. cast-iron line. The scrubbers are 13 ft. high and 4½ ft. in diameter and are located just outside the boiler house.

The compressors force the gas through cast-iron distributors to the coagulation basins. Hard-rubber pipes 1½ in. in diameter are placed on the outlet side of the baffles at the outlet end of the coagulation basins 8 ft. below the surface of the water. These pipes are perforated with ⅛-in. holes on 2½-in. centers through which the gas passes. A Venturi meter in the head house indicates the amount of gas being used and a recorder shows the CO_2 in the scrubbed gases.

Chlorine apparatus, installed in the head house, is arranged for treating the water in the effluent conduit but results have indicated so far that with the lime treatment an effluent can be consistently produced containing less than 10 bacteria per cubic centimeter.

The contract for the plant was awarded in August, 1922, and the plant was placed in operation in September, 1923, but the formal opening was deferred until March 27, 1924, when all its parts had been tuned up. The results have been satisfactory. The plant was designed and built under the supervision of A. S. Holway, chief engineer and superintendent of the water department until July 31, 1923. On that date Mr. Holway resigned to join the staff of the Holway Engineering Co., consulting engineers, Tulsa, Okla., and C. E. Bretz, assistant superintendent, became superintendent of the water department. The detail design of the plant, plans and specifications were drawn by Mr. Bretz, who also was field engineer in charge of construction and, with C. H. Spaulding, chemist in charge, put the plant into operation. Robert Spurr Weston, consulting engineer,

Boston, reviewed the plans and suggested the use of the carbonating system. Valuable suggestions were made, as the work progressed, by a Board of Advisory Engineers consisting of V. V. Long, H. E. Musson, George W. Knox, B. S. Byers, E. L. Gantt, all consulting engineers of Oklahoma City. The water-works improvements are under the Department of Public Property for which Joe H. Patterson is commissioner and B. M. Hart, city engineer. Tibbets & Pleasant, of Tulsa, were the general contractors and the American Water Softener Co. furnished the filter equipment.

Certain Relations of Water to Soil in Irrigated Land

AN EXHAUSTIVE study of soil difficulties that have developed in most of the Western irrigation districts has been carried on for a number of years by the U. S. Department of Agriculture. These difficulties include waterlogging, increased alkalinity, and progressive laws of perviousness of the soil. In some cases there has been difficulty in draining the soil, in others bare and sterile spots have developed, and in others it was impossible to leach out excessive alkali because the passage of water through the soil could not be made rapid enough to carry away the excess salt. Most of these phenomena have now been found to depend upon obscure interactions between the irrigation water and the soil. A monograph summarizing what has been learned about the problem to date has just been published by C. S. Scofield, of the Office of Western Irrigation Agriculture at Washington.

According to the facts developed in this study, coagulation of various soil constituents under the influence of sodium salts has the effect of making the soil impermeable and useless for agricultural purposes. In some fields which exhibited this action it was found only in irregularly distributed spots, so that there were permeable and impermeable places; both the rate of vertical and lateral flow of water through the soil and its chemical composition differed widely at points within a very few feet of each other. It has recently been found that the most effective way of dealing with this condition is to balance the alkali bases (sodium and potassium) by an adequate proportion of calcium and magnesium. The following conclusions are quoted from the monograph:

The effective supply of water that may be stored in the soil to last from one irrigation to the next is limited on the one hand by the field carrying capacity and on the other by the inability of the plants to take water from the soil beyond what is known as the wilting point.

The soil may hold as much as 6 in. of water per foot of depth, but ordinarily its net effective storage capacity is not much above 2 in. per foot of depth.

The subsoil, which is usually more compact than the surface soil, may become saturated when it contains 5 in. or less per foot, and the addition of 1 in. of water to a saturated subsoil may raise the level of the underground water as much as a foot.

The physical condition of the soil and particularly its permeability to water is largely influenced by the character of the bases that are combined with the soil. When the alkaline bases, sodium and potassium, predominate the soil is deflocculated and impermeable. When the earthly bases, calcium and magnesium, are in excess the soil is flocculated and permeable.

When saline soils are leached to reduce the concentration of the soil solution it is often found that they become impermeable to water. This condition is due to the effect of the alkaline bases combined with the soil, which causes deflocculation to take place when the salts of the strong acids, sulphates and chlorides, are removed from the solution.

Where the subsoil of an irrigated field is saturated with water or contains strata or barriers that are slowly permeable to water, effective leaching of the soil is seriously hindered because of the accumulation of underground water.

The lateral movement of underground water, like the downward movement of water through the soil, is subject to great variation, depending upon local conditions, and the quality and concentration of the soil solution are also highly variable even within the same field.

Comparison of the quality and concentration of underground waters from different parts of the field with those of the irrigation water permits a better understanding of the drainage requirements of the soil than is possible from observing only the depth of the underground water.

The injurious effects that have been ascribed to sodium carbonate or "black alkali" in irrigated soils appear to be due to the sodium rather than the carbonate, and sodium in solution even when associated with the stronger acids combines with the soil and ultimately causes deflocculation and impermeability.

The readjustment of the relative proportions of sodium and other bases in an impermeable soil, to the end of improving the physical condition, depends upon replacing the sodium with another base, such as calcium or aluminum, which when combined with the soil brings about a flocculated and permeable condition.

Cherbourg to Become New French Transatlantic Port

Special Correspondence

FRANCE has felt the lack of sufficient transatlantic port facilities for passenger liners for a number of years. During the War, when Brest was so largely used as a port by American troop transports, the possibility of using this most westerly transatlantic port for fast passenger service was considered. But because of the fogs and dangerous entrance to the harbor and the long distance by rail to Paris, the project was abandoned.

Cherbourg, at the tip end of the Contentin Peninsula in Normandy, was then designated as the chief port of call for foreign liners making the transatlantic crossing with passengers. But here the lack of an inner port and the meager facilities for handling passengers by tender and the limited dock and rail facilities was called to the attention of the authorities as requiring improvement if the port was to compete with other ports less advantageously located. It is pertinent to state that the German steamship lines first called attention to the advantages of this port of call, only four hours from Paris by fast train, for disembarking passengers (and passengers only) in competition with the French line, whose home port is Le Havre, a port some five hours steaming distance beyond. Now, the Cherbourg interests, in competition with those at Le Havre, have at last defined a project for immediate execution which provides the necessary facilities for the port.

The plans call for a wharf 600 meters long, with two-story embarking shed, the upper for passengers and the lower for baggage, a covered carriageway 250 meters long, and 240-meter platforms at each side of the branch line of the Chemin de Fer d'Etat, which will be extended onto the wharf. The entire structure will be surrounded by a wide promenade. The new work as planned will be of reinforced concrete and steel construction.

Good Practice in Oiled Road Construction

Oiled Roads Properly Constructed Good in Illinois for Ten Months and Passable in Normal Seasons All the Year

By Wilbur M. Wilson
Research Professor, Structural Engineering, University of Illinois, Urbana, Ill.

Extract from the University of Illinois Bulletin, Circular No. 11, issued by the Engineering Experiment Station, giving full details of tests.

APPROXIMATELY 40,000,000 gal. of road oil were used on the highways of Illinois during the year 1923. The cost of this oil, applied to the roads, was about $3,000,000. The use of road oil as a means of preserving the roads of Illinois has not been an unqualified success. Some oiled roads have been complete failures, but in the majority of cases a moderate degree of success has been obtained. Many oiled roads constructed by the regular road officials have remained in good condition throughout most of the year. The high degree of success obtained in some cases emphasizes the possibilities of oiled roads when properly constructed and maintained, and likewise emphasizes the economic loss due to inferior practices.

The investigation on oiled roads conducted by the University of Illinois has extended over two years, 1922 and 1923. The 1922 observations were made on a road 12.33 miles long. The 1923 investigation was made on a road 6.5 miles long. The object of the investigation was to obtain information concerning the failure of oiled roads and to formulate recommendations for the satisfactory construction of such roads.

The conclusions are based upon observations made partly on the experimental roads and partly on other roads in central Illinois constructed by the regular road officials; the practice recommended in this circular has been compared in a general way with that of the most successful of the regular road builders.

Recommended Practice—As a result of observations on the experimental roads and on other roads in central Illinois, the following practice is recommended for constructing a high grade oiled road of loam and clay soils similar to those found in central Illinois:

1. Bring the road to a hard smooth surface each year. If the road is not well shaped it should be completely regraded. If it has been previously graded, a large grader outfit should be used to clean out the ditches; one round in the ditches and one round on the shoulders spreading the spoil are usually sufficient. This work should be done early in the spring.

2. Maintain the road with a patrol, beginning as soon as the grading has been finished or the ditches have been cleaned. If a motor patrol is used, a separate outfit should be provided to work on the places that have a tendency to soften.

3. For a roadway 28 ft. wide, give the road a crown of approximately 9 in. where the soil is firm, and of 12 to 15 in. where the soil is spongy.

4. Delay oiling until the roadbed is thoroughly consolidated.

5. If the road is dusty, scrape or sweep the dust off before oiling in order that the oil may penetrate into the solid body of the roadbed.

6. Put on enough oil to make a good road. For a firm soil well drained, 3 qt. per square yard is recommended for a road being oiled for the first time, and 2 qt. per square yard for a road that has been oiled successfully the previous year. Portions of the road where the soil conditions are not favorable should receive 1 to 2 qt. of oil per square yard in addition to the amounts specified above. This additional oil should be applied in the fall and it should be applied to those portions of the road where there are indications of failure.

7. Use oil that contains a solid residue of a least 55 per cent.

8. Apply the oil with a pressure spreader.

9. Heat the oil before it is applied.

This recommended practice contemplates a road subject to the heaviest traffic that an earth road may properly be expected to carry. It is realized that road officials do not have sufficient funds to oil all the roads in accordance with these recommendations. Moreover, there are many roads that do not carry sufficient traffic to justify the construction of a high-grade oiled road that are, nevertheless, of sufficient importance to justify an attempt to make them passable for automobiles throughout the year. No attempt has been made to formulate recommendations for the construction of roads carrying light traffic because sufficient data are not available to answer the large number of questions involved. There are, however, two pertinent facts bearing upon these questions that are quite evident.

1. In the analysis of the cost of a high-grade oiled road, one-sixth of the total cost is for the preparation of the roadbed and five-sixths for the oil.

2. Experience teaches that a good roadbed is absolutely essential for the construction of a good road.

These facts indicate that, if the cost of a road must be reduced, it should be reduced by decreasing the amount of oil rather than by neglecting the roadbed. Too much emphasis cannot be placed upon the necessity for having a roadbed that is smooth, well shaped, thoroughly consolidated, and free from dust and loose earth before the oil is applied. One dollar spent on preparation of the roadbed is worth many dollars spent for oil. Parts of the road that are most likely to disintegrate should receive special attention, both in grading and oiling.

A New York Water Company Awarded $4,755,954 for Works

THE CONDEMNATION commission created to determine the price to be paid by the City of New York for the property of the Citizens Water Supply Co. which supplied the second ward of Queens Borough, taken over by the city on April 19, 1922, has fixed the price at $4,755,954, plus $114,221 for legal expenses allowed to the company. The company had claimed $9,674,971 and the city placed a valuation of $2,228,651 upon the property. The main items in the valuations of the company, the city and the commission are shown in the accompanying table. It will be noted that the commission allowed only $1 for franchise rights against a claim of $1,250,000 by the company. The commission held that the company's franchise was not exclusive, and that there was nothing to prevent the city from paralleling the lines of the company.

COMPARISON OF COMPANY, CITY AND COMMISSION VALUATIONS

	Claimed by Company	Conceded by City	Awarded by Commission
Structural property	$117,101	$31,711	$117,100
Collecting system	384,180	94,228	279,019
Machinery and equipment	416,871	164,852	322,115
Transmission and distributing system	3,563,573	1,171,865	2,554,319
Lands and water sources	2,529,337	765,995	1,223,400
Going concern	750,000	.....	200,000
Franchise	1,250,000	.....	1
Severance damages, Station 9	663,909	.....	60,000
	$9,674,971	$2,228,651	$4,755,954

In addition to the award for the property the commission allowed the company $2,000 for council fees; $65, costs; $112,156, expenses; total, $114,221. Added to the valuation, this makes a total of $4,870,175 to be paid by the city to the company. The cost to the city of the condemnation proceedings has not been reported.

Among the witnesses who testified for the company were N. S. Hill, Jr., C. C. Vermeule, M. R. Sherrerd and Prof. Irving Fisher. Some of those who testified for the city were Prof. W. H. Burr, Prof. G. C. Whipple and Delos F. Wilcox; also Col. Merritt H. Smith, chief engineer, and W. W. Brush, deputy chief engineer, Bureau of Water Supply.

Geodetic Survey Makes Precise Ice Traverse in Minnesota

Frozen Deep-Water Channel of Rainy and Namakan Lakes Followed in Tracing Minnesota-Ontario Boundary

By Casper M. Durgin
Junior Hydrographic and Geodetic Engineer, U. S. Coast and Geodetic Survey

THE U. S. Coast and Geodetic Survey during the past winter completed a line of precise traverse from International Falls, Minn., eastward for a distance of 55 miles across the ice of Rainy and Namakan Lakes and measured a base line nearly five miles in length on Namakan Lake.

The deep water channels of Rainy and Namakan Lakes form a link of international boundary between Minnesota and Ontario, Can. Precise triangulation or precise traverse was desired along this section of the boundary. The shores of the lakes are heavily timbered, and to attain the proper strength of figures for triangulation would have necessitated the building of high towers about five miles back from the shores of the lakes in country where there are no trails, making the triangulation slow and expensive. It was decided, therefore, to run a line of precise traverse across the lakes locating the traverse stations on rocky islets or points on the shores of the lakes and to make the tape measurements over the ice.

During the fall of 1923 a party with launches located and marked the stations and observed the horizontal angles. Twenty-three stations were marked at an average distance apart of a little over two and one-half miles. The last two stations in Namakan Lake formed the ends of a base line about four and three-quarter miles in length, from which triangulation could be carried eastward. Early in January a party equipped for ice traverse began work at International Falls. The party consisted of nine men: two to make contacts at the ends of the tape, one to record, two to stretch the tape to the proper tension, one to support the middle of the tape, one to line in the tape supports, and two to move forward the tripod supports for the tape ends. Fifty-meter base tapes of invar metal were used, supported at each end by tripods 3½ ft. tall and at the middle by hand. The tripods, similar to level tripods, had sharp bronze feet so that they could be placed firmly on the ice. At the top of each tripod was an iron casting with a flat top connected to the tripod with a ball-and-socket joint. On the top of this casting was fastened a steel decimeter scale graduated to millimeters.

The tripods were lined in with a transit and set firmly on the ice; then the tripod legs were tightened by means of thumb screws and the scale on the top was adjusted by means of the ball-and-socket joint to the slope of the tape in line with the direction of progress and with the zero end of the scale forward. The man who made rear contact held the zero mark of the tape at the zero mark of the scale on the rear tripod. The man at front contact read the point where the fifty-meter mark of the tape came on the scale of the front tripod. This reading was recorded as a set-up or an amount to be added to the length of the tape. Five tripods were used so that two could always be in place to hold the tape end with a check and two could be on the way forward while the fifth was being placed.

Two poles with sharp bronze feet were used to stretch the tape. These poles were graduated like level rods, one in feet and the other in meters, and were used not only to stretch the tape but also to measure the height of the tripods above the ice, which was considered level, so that the inclination correction could be determined. Wherever the traverse line was on land, as was the case near the traverse stations, the difference of elevation of the tops of the tripods was determined by means of a level. A thermometer was attached to the tape to determine the temperature correction.

The traverse, 55 miles long, was not only measured accurately in one direction with invar tapes but was also given a check measurement with a 300-ft. steel tape supported on the snow. The base, four and three-quarter miles long, was measured accurately in both directions with invar tapes. Both the traverse and the base line were completed in 26 calendar days which included six stormy days on which no work was possible and four Sundays. The average progress was four miles per day. The progress would have been still greater but for the fact that an average daily walk of five miles each way to and from work was necessary.

RUNNING 55-MILE TRAVERSE ON ICE

The temperature during working hours averaged about 10 deg. F. below zero with a minimum of 40 deg. below. The ice was covered with about 20 in. of snow but this did not hinder the use of the tripods. The party had tripods with them 6 ft. high for use in case of heavy snowfalls, but they were not required.

The best opportunity to study the possibilities of ice movement which could be caused by currents in the water, strong winds, or marked changes in the temperature was an expanse of open lake about nine miles square, with three very small islands in the center, which was crossed by the traverse line. The ice was firmly attached to the ragged shore and no movement could be detected except a few small cracks about 5 mm. in width which appeared only during extremely cold nights. The base line was measured over an expanse of nearly open lake about five miles square, and has a probable error of only about 1 in 350,000. It was measured on different days with temperatures differing by 15 deg. but no movement of the ice could be detected when checking on stations one kilometer apart marked on stakes frozen into the ice or when checking each day on a mark on a rocky islet near the middle point of the base line.

Analysis of Grading Curve for Concrete Aggregates

A Mathematical Study of the Size Gradation of Sand and Stone To Co-ordinate the Various Measures of Grading Such as Fineness Modulus, Surface Area and Density Ratio

By L. I. Hewes
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MUCH ATTENTION has recently been given to measured properties of concrete aggregate, especially quantities associated with the grading curve. There have been used such quantities as the "uniformity coefficient,"[1] "fineness modulus,"[2] the "surface area,"[3] "surface modulus" and "density" and "solidity ratio,"[4] but satisfactory relationships between these quantities have not been established. There is some lack of uniformity in definition and notation in the discussions; for the grading curve the per cent of the aggregate passing a given screen is frequently used as an ordinate, but the per cent retained on a given screen has also been used. There are different systems of graduation of screen sizes in use and the convenient logarithm of the sizes of screen is very common. If the grading curve is to be accepted as a fundamental description of concrete aggregates, increased agreement as to its definition and use will be helpful and it is also desirable to study further the derived properties of aggregates. With this in mind, and with full recognition of the complexity of the problem of the determination of the necessary and sufficient conditions for good concrete, the following study of the grading curve and its derived properties is presented.

Grading Curve—For the purpose of this paper, grading curves will be plotted with per cent retained on the screen as the ordinate corresponding to the size of the screen. The following notation will be used:

y = per cent by weight of sample retained
x = size opening in inches of screen.

It has usually been assumed for the grading curve that the sizes of aggregate vary continuously. The largest size is usually arbitrary and from ¼ in. to several inches. To eliminate the restriction of any set of screen sizes there is sometimes used here an assumed unit size for the largest-sized particles with corresponding smaller sizes expressed as fractions of the largest size and discontinuity of sizes may occur.

There are derived from the grading curve additional data from which to study in particular "density," "fineness modulus" and "surface area" and their relations. The discussion concerns only what may be termed geometric properties of the aggregate and the qualities of stone are assumed satisfactory and constant. To develop limiting relationships between various measured quantities, it will serve the purpose to assume that the aggregate is a rounded or a gravel aggregate, and also for most of the discussions that the various sizes are spherical.

There are shown in Fig. 1 several grading curves for purposes of comparison. The Fuller curve has been shown in conformity with the adopted methods of plotting.

The geometric properties of the aggregate exhibited by the grading curve need not at the outset include questions of difficulty or ease of manipulation under the existing mixing methods. This discussion aims rather to bring forward properties true for all aggregates, irrespective of the present stage of the processes of mixing concrete. It will be helpful if such questions are temporarily deferred.

There are evidences that the function of coarse aggregate in concrete is primarily economic. Coarse aggregate, by increasing bulk, diminishes cost. Concrete of satisfactory crushing strength can probably be made without any coarse aggregate, and doubtless increased quantities of coarse aggregate can be successfully used providing the correct quantities of cement are always used. Doubtless the dimensions of the aggregate of largest size are commonly regulated by considerations of workability, presence of reinforcing steel, size of forms, and so on, and most grading curves show the presence of a relatively small fraction of the larger-sized particles.

Homogeneity—Uniformity of product is very desirable, consequently if any coarse aggregate of a given maximum size is desirable, it follows that in theory a sufficient amount of such sized coarse aggregate should occur to produce uniformity or homogeneity in the product. Any sample of the product upon analysis should contain approximately the same percentages of the various sizes of the aggregate ingredient. The term "well graded" aggregate has possibly been used in many instances to describe what was really continuous variation of sizes according to some law, or to indicate that there were no gaps or discontinuities in the range of sizes in the sample. It is known, however, that continuity alone in the variation of sizes of the various fractions of an aggregate does not necessarily insure practical or theoretical density. As indicated, it has been customary to permit only small quantities of the largest sizes of aggregate, but if the aggregate is to be uniformly distributed, and if there is justification for the largest sizes, then there is justification for the presence of larger sizes throughout the product. With a restriction to 5 per cent of the largest-sized aggregate in a mix, it is manifestly impossible for such largest-sized particles to be so uniformly distributed that a constant percentage of that size should be in any sample of say twice the linear dimension of the particle. Five per cent, for example, of a 3-in. maximum size aggregate does not insure that any 6-in. cube sample will contain any of the 3-in. fraction. It may not be sufficient that such sample contains aggregate of smaller sizes in sufficient quantity to produce an equivalent total of coarse aggregate content.

Such reasoning, continued step by step, would in theory permit the justification of grading to any (smaller) maximum size. It is desirable to ask frankly what determines the presence of larger sizes at all, and next what percentage of largest size is desirable. Is there reason (other than limitation of workability) why the larger sizes of coarse aggregate may not increase from a maximum of 5 per cent to a maximum of 25 per cent? The theoretical grading curve, shown

in Fig. 1 and discussed below, indicates the presence of far greater fractions of coarse sizes than any of the aggregates for which grading curves have been formed.

Surface Area—An exact determination of the total surface area of the particles in concrete aggregate is manifestly impossible, but approximations of this quantity have been useful. The surface area of the particles, calculated on the assumption that all the particles are spheres, can be determined from the grading curve and is a sufficiently useful index of that (surface area) aspect of the aggregate. For calculations by any method it is always necessary to assume that the particles have some regular geometric form, and the number of separate forms is strictly limited. But since it is possible to express the surfaces of commonly assumed regular solids, such as cubes, in terms of an associated spherical surface, the spherical assumption will not distort the conclusions that follow. Again, the total surface area of any sample which is allowed to include a considerable fraction of fine aggregate will be entirely determined by the surface area of the finer fractions. That is to say, regardless of the surface area of the several fractions of coarser aggregate, the total surface area can be made to approach almost any desired figure by slightly varying the small percentages of the finest sizes only. So if the surface area of coarse aggregate alone has intrinsic significance it must be considered separately from the surface area of sand. The division between sand and coarse aggregate is usually at the ¼-in. screen, but it may also for convenience be assumed to occur at a size of screen which is about 10 per cent of the unit size assumed for the largest particles.

If y represents the fraction of an aggregate (assumed unity) retained between consecutive screens of size x and $x + \Delta x$, the surface area of the fraction between the screens may be calculated thus: The volume of each of the spherical particles of size x occurring between the screens is represented by $\Delta v_s = \pi x^3/6$. If this volume is divided into the fraction Δy the quotient is the number n of such sized particles in this fraction. The surface of each spherical particle of diameter x will be $\Delta S_s = \pi x^2$; consequently the total (spherical) surface ΔS of the particles in the fraction will be represented by

$$\Delta S = n\pi x^2 = \frac{6\Delta y}{\pi x^3} \cdot \pi x^2 = \frac{6\Delta y}{x}$$

The total surface S of the sample will accordingly be approximately

$$S = 6\sum \frac{\Delta y}{x}$$

and in the limit (when Δy is allowed to approach zero) the total surface S may be expressed as the following definite integral:

$$S = k_1 \int_0^1 \frac{dy}{x} \qquad (1)$$

where k_1 is a constant depending on assumed quantities. Naturally there exists no explicit functional relation (mathematical) between the per cent y retained upon the screen of size x. But if the grading curve could be expressed mathematically, the above definite integral could usually be evaluated and the spherical surface area exactly determined. However, the concept of the surface area as a definite integral results in an easy determination by graphical methods of an approximate value or index of the surface area for the sample The definite integral of equation (1) can be shown to represent an area between the vertical axis, a standard curve associated with the grading curve, and the line $y = 1$. This associated curve results from the grading curve if the percentages y retained upon each screen of size x are replotted, not against the size x but against the reciprocal of the size x.

Fig. 2 shows the associated curves for several grading curves. Analytically, if $x' = 1/x$ it is seen that the definite integral defining the spherical area may be rewritten:

$$S = k_1 \int_0 x' dy \qquad (1')$$

in which the integrand x' represents the reciprocal of the size and in which dy still represents the increment of the percentage retained and k_1 is a constant which depends upon the specific gravity of the aggregate and the scale for plotting and the maximum size diameter. To evaluate the surface area in square inches per pound, it will be necessary to know the specific gravity of the material. The graphic method has been applied to those grading analyses presented by Abrams,[2] with an assumed specific gravity of 2.65, and the following tabulation shows the degree of check, which is about 16 per cent on an average.

TABLE I—SHOWING COMPARATIVE SURFACE AREAS

Abrams No.	Abrams Surface Area	Surface Area by Graph	Abrams No.	Abrams Surface Area	Surface Area by Graph
40	602	680	272	1,315	1,530
259	569	650	273	911	1,077
260	764	885	274	1,992	2,350
261	999	1,157	275	1,076	1,258
262	1,292	1,510	276	390	444
263	1,451	1,670	277	557	653
264	1,565	1,860	278	483	540
265	761	883	279	514	577
266	616	723	280	1,276	1,650
267	709	795	281	701	780
268	834	1,048	282	697	776
269	898	1,070	283	689	770
270	1,391	1,620	284	685	771
271	672	794			

The value for k_1 for the above calculation was determined by the specific gravity 2.65 and a vertical scale of 1 in. representing 20 per cent, and a horizontal scale for reciprocals of 1 in. representing 10, thus:

$$k_1 = \frac{1728}{62.43} \times \frac{1}{2.65} \times \frac{2}{10} \times 10 \times 6 = 125.5$$

From this curve associated with the grading curve it is clearly seen, as stated above, that the coarser sizes of aggregate have comparatively little influence on the total surface area and that the finer sizes completely dominate the measurement of the total surface area. Indeed the total surface area S may become infinite as x approaches zero.

The measure of surface area determined by the associated curve was for the results tabulated above, made by planimeter readings. A quick approximation could, however, be made by careful estimating from cross-section paper. The scale used was rather large to avoid error in a first tryout of this method. It is to be noticed that since y represents a quantity essentially of three dimensions and dx a quantity of linear dimensions, the quotient is necessarily of two dimensions, that is, represents area. This aspect of the analysis will be useful in what follows.

Fineness Modulus—The fineness modulus has been variously defined and calculated. Analytically it is used as the sum of the successive percentages (fractions of unity) retained on the Tyler set of screens. Frequently the upper screen size discussed has been 1½ in., sometimes 1½ in., and less often of larger sizes. The

fineness modulus has also been defined for convenience as the area below the grading curve when the latter is obtained by plotting the percentages retained on a given size against the logarithmic (to base 2) of that size, using the Tyler screens and with a convenient unit of measure for size 100. To develop physical significance for the fineness modulus and for comparison with other measurements, it is desirable to be free from the limitations of any set of screens since the quality represented by fineness modulus must inhere in the aggregate and not in the particular units for which the aggregate is measured. Fig. 2 shows typical grading curves plotted to logarithmic abscissas as above defined for the Tyler set of screens. From the definition of the fineness modulus as the area below this plotted grading curve in this figure, the physical significance of the fineness modulus may be analyzed as follows:

The actual area below the grading curve is given by the relation:

$$m = K_1 \int_{\log_2 d}^{\log_2 D} y\,dx'$$

where m = area (also fineness modulus)
K_1 = a constant
D = diameter of largest particles considered
d = diameter of smallest particles considered
x' = logarithm to base 2 of diameter x of particles retained.

Then since

$$d(x') = d(\log 2x) = \log_e 2\,\frac{dx}{x}$$

there results:

$$m = K_1 \log_e 2 \int_d^D \frac{y}{x}\,dx \qquad (2)$$

The integrand or the ratio y/x is of course the ratio of the percentage y of particles of size x to the corresponding size and is essentially a two-dimensional quantity. When integrated with respect to x the result is of course essentially a three-dimensional quantity or volume. It is at once clear, therefore, that the fineness modulus m as re-defined by equation (2) can have no explicit functional relation with the surface area S as defined by equation (1). It is interesting to note, however, that the rate of change of the fineness modulus with respect to the screen size is proportional to a certain surface area associated with that size, for upon differentiating m with respect to x there results:

$$\frac{dm}{dx} = K_1 \log_e 2\,\frac{y}{x} \qquad (3)$$

But the quantity y/x is proportional to the total equivalent surface area if all particles in the fraction y were assumed to be of size x.

For purposes of checking the physical significance as above outlined, for the fineness modulus, the area defined by plotting the curve y/x against the size x was computed for several examples given by Abrams, using specimens of aggregate for which 100 per cent was retained on the Tyler screen of size 100, and also specimens for which a fraction passed this mesh and which was assumed to be caught on a lower sized mesh of size 0.0041.

Table II gives the comparative results.

For this work the horizontal scale chosen was 1 in. = 5/100, and the vertical scale for the ratio (per cent) 1 in. = 1,000. Consequently one square inch represented $\frac{1}{2}$, therefore from equation (2) for fineness modulus it is necessary, for relating the resulting area in square inches to the fineness modulus, to multiply the planimetered areas by the constant K defined as follows:

$$K = \tfrac{1}{2}\log_e 2 = \tfrac{1}{2}\,\frac{\log_{10} 2}{\log_{10} e} = 7.2134$$

By inverting the processes of reasoning above, the fineness modulus may be said to have the following physical significance: if a surface area for each retained fraction is computed on the assumption that the particles of which the fraction is composed are all of the minimum size within the fraction and spherical, and this surface area is then multiplied by the increment of size (Δx) of the particles, and the limit of the sum of these products is taken, there results a certain volume which has been called the fineness modulus. Or again, if the ratio of the retained percentage to a given size is multiplied by the increment of size and the sum of these products is taken throughout the range of size, there results a quantity called the fineness modulus.

TABLE II—COMPARATIVE VALUES OF FINENESS MODULUS

Abrams No.	Abrams Fineness Modulus	Recalculated Fineness Modulus	Abrams No.	Abrams Fineness Modulus	Recalculated Fineness Modulus
262	6.04	6.26	272	6.04	6.14
264	6.04	6.00	274	6.04	6.02
265	6.04	6.03	275	6.04	6.03
271	6.04	6.04			

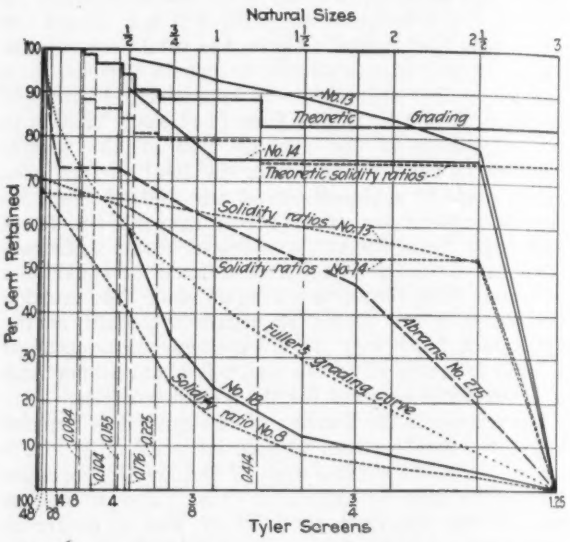

FIG. 1—TYPICAL GRADING CURVES FOR AGGREGATES
Maximum size is unity for the theoretic grading curve and also for the Fuller curve. Maximum size is 3 in. for Nos. 8, 13 and 14, and 1.25 in. for No. 275.

It is clear that an infinite number of grading curves when plotted will yield constant natural area, also that an infinite number will yield constant fineness modulus. It is equally true that an infinite number of grading curves will yield constant surface area. If coarse aggregate alone is to be considered, the least that may be said concerning the relationship of the fineness modulus and surface area is that a large fineness modulus is usually associated with a corresponding large area below the grading curve and also a small surface area.

Density—There is shown in sufficient detail in Fig. 1

a theoretical grading curve for the densest pack of spherical particles of seven sizes. The derivation of the percentages of the respective sizes of such a spherical pack does not involve any violent assumptions. The largest spheres of unit size (or of radius R) are assumed to be accurately arranged tangent to each other in the most compact manner in successive layers, and if there are n^2 spheres in each layer, the gross (or equivalent solid) volume V of n layers occupied by a pack of n^3 spheres of radius R is:

$$V = 4n^3\{\sqrt{2}(n-1) + \sqrt{3}\}R^3$$

and the actual volume of these n^3 spheres of largest size R is:

$$V_1 = 4/3\,\pi n^3 R^3$$

The ratio of these two volumes of the "solidity ratio" of the largest size only is 0.7405, and is computed from the relation:

$$\frac{V_1}{V} = \frac{\frac{4}{3}\pi n^3}{4n^3\{\sqrt{2(n-1)+\sqrt{3}}\}}$$

where the number of particles n^3 is taken sufficiently great. It is then desirable to know the effect in the reduction of voids by an introduction into the voids of successive sets of smaller spheres and tangent always to four of the spheres of the theoretical pack of the larger-sized spheres already in place. The next sized spheres after the largest, as is well known, have a radius $R_1 = 0.414R$ and the recalculated solidity ratio found as before is then 0.7929. There was calculated in this way for the exact grading curve of the theoretical pack of Fig. 1 the effect of introducing five additional sets of spheres whose radii were calculated so that the successive sets of smaller spheres were each exactly tangent to four of the previously packed spheres. Table III shows the corresponding calculation.

It will be noted in this table that the per cent of the loose sample retained is very large for all of the first four sizes found.

For further discussion of density, the following notation will be used:

W = weight of solid equivalent to the gross volume of the sample considered
W_1 = weight of the sample
d_y = solidity ratio of any fraction y retained
d = solidity ratio of entire sample.

It is evident that:

$$d > d_y$$

and that:

$$Wd_y = yW_1 \text{ or } d_y = y\frac{W_1}{W} = yd \qquad (4)$$

and since $d < 1$

then $d_y < y$

or the solidity ratio of the fraction retained on any screen is always less than the percentage of the sample retained. In Table III is shown under the column "differences" the value of $y - d_y$ for the theoretical pack of spheres. For any grading curve it is evident that there is an associated curve which may be called the solidity ratio curve *and this solidity ratio curve will lie below the grading curve and its shape will in general conform to that of the grading curve.* The solidity ratio curve is shown in Fig. 1 for the theoretical pack of spheres and for several actual samples of gravel. In calculating the ordinates for this solidity ratio curve, it is merely necessary to know the density or solidity ratio of the entire sample and the respective percentages retained. The corresponding ordinates d_y are then calculated from equation (4). This curve simply presents an obvious fact that there remains after the retained fraction a greater percentage of voids in the total unit volume occupied by the entire loose sample than the percentage of the sample which passes the screen in question.

TABLE III—SHOWING THEORETICAL SPHERICAL GRADING

Size	Per Cent Retained, y	Solidity Ratio, d_y	Differences $y-d_y$
1.000	82.78	74.05	8.73
0.414	88.65	79.29	9.36
0.225	90.53	80.98	9.35
0.176	94.12	84.19	9.93
0.155	96.61	86.41	10.20
0.104	98.84	88.42	10.42
0.084	100.00	89.44	10.56

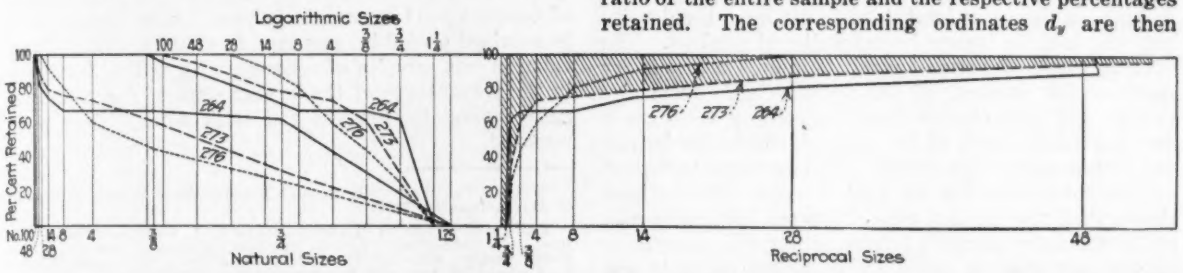

FIG. 2—GRADING CURVES FOR THREE DIFFERENT SANDS FOR LOGARITHMIC, NATURAL AND RECIPROCAL SIZES

It will be seen that there are two interesting characteristics of the theoretical grading curve for the dense spherical pack. First, the high percentage of the largest sizes associated with theoretical maximum density. From this characteristic by comparison it would appear that grading curves more nearly approximating the theoretical spherical grading curve would tend to insure uniform distribution of the larger sizes throughout the product without reducing density. Second, the absence of what may be termed intermediate sizes between the largest size spheres and the spheres of size 0.41. It is quite possible that this qualification as reflected in actual grading would tend to diminish "wedging effect" which is thought to upset the theory of voids in practical mixing.[5] Certainly the theoretical grading curve indicates favorable conditions for resisting such action.

The favorable curve of solidity ratio, due to the absence of intermediate sizes, is reflected to a limited extent in some gravel samples whose grading curves are also shown in Fig. 1. These samples were uncrushed gravel with large sizes nearly spherical and passing a 3-in. opening, but with smaller sizes somewhat elongated. The average solidity ratio of four of the deleted samples such as No. 14, well shaken, was 0.715.

The corresponding solidity ratio for the same gravels with intermediate sizes included, such as No. 8 and No. 13, was 0.685, and for several well shaken samples of one size only of gravel from the same source, was 0.654. Seven "loose" samples of the single sizes had an average solidity ratio of 0.573 and six loose samples with all fractions retained 0.651, and for four loose samples with the 1½- and 2-in. sizes removed 0.694. In practice the solidity ratio indicated by the theoretical spherical pack for the various fractions or for the entire sample could not even be approximated, yet the curve serves as a comparison standard of considerable value. It should be noted that this theoretical grading curve is not limited to coarse aggregate but, as will be seen from Table III, both the solidity ratio and the per cent retained are independent of the largest size (assumed unit) and therefore apply to a similar grading of spherical particles composing a sand. (See paper in this connection by C. M. Chapman before Sec. D, Am. Assn. Adv. of Science, Columbus, Ohio, 1915. Reprinted, *Better Roads and Streets*, April, May, 1916.)

Summary—It has been shown that a large increase in the percentages of coarsest sizes in coarse aggregate will not, in theory at least, tend to diminish the density but will tend to insure homogeneity of product. The grading curve of coarse aggregate affords a means for studying the progress of the soliditiy ratio from size to size, and it is clearer from the solidity ratio curve how a grading curve of low percentages in the largest and intermediate sizes requires the aggregate to depend on the finer sizes for its final density. It has been shown that the surface area of coarse aggregate may be immediately calculated from either the natural or logarithmic grading curve by graphical methods and that grading curves of high solidity ratios are likely to produce corresponding low surface area. It is shown that there is no necessary relation which may be expressed mathematically between the surface area of the coarse aggregate and the fineness modulus and that the fineness modulus may be regarded as a certain associated or representative volume, also that in general low surface areas will be accompanied by high fineness moduli.

It is possible, however, to grade an aggregate so that the surface area will be proportional to the fineness modulus when computed for each fraction or for the entire sample. The rate of change of the surface area with respect to the size of an aggregate is

$$\frac{dS}{dx} = \frac{k_1}{x}\frac{dy}{dx}$$

and similarly the rate of change from the fineness modulus is:

$$\frac{dm}{dx} = k_1 \log_e 2 \ \frac{y}{x}$$

If these rates are to be equal there results:

$$\frac{dS}{dx} = \frac{dm}{dx} \text{ or } \frac{1}{x}\frac{dy}{dx} = k_1 \ \frac{dy}{dx}$$

from which upon integration there result:

$$\log y = ax + b \text{ or } y = me^{nx}$$

In other words, if the relation of per cent retained to size is defined by this equation with suitable choice of the arbitrary constants m and n, the resulting surface area will be proportional to the fineness modulus, but apparently there is no special significance from this choice of a grading curve.

It is believed that the above analysis tends to reconcile an apparent conflict between the significance of the measured quantities that have been used and that were cited at the beginning of this article. Since also, in general, low surface area will be associated with high density, it is a favorable indication in harmony with the theories of Talbot,[4] and Crum,[6] and also is in accord with the conclusions of Messrs. Wig, Williams and Gates.[5]

It is worth noticing that the surface area of a pound of the spherical aggregate of the theoretical spherical grading, as found by actual calculation, is 87.58 sq.in., against 88.38 sq.in. determined by the graphical method. The corresponding fineness modulus was 8.5.

The evidence in favor of increasing the quantities of coarser fractions of the aggregate (especially of spherical gravel aggregate) seems clear, at least in those cases where questions of "workability" are subordinate and where the concrete is of sufficient mass to permit economical use of larger sizes. Some of the best concrete roads of 7 or more inches in thickness have been constructed with a coarse aggregate specification that permits a maximum of 18 per cent of coarse gravel aggregate to pass a 5-in. opening and be retained on a 3-in. opening. It would doubtless be of value to test samples of concrete with radical increases in the percentages of the largest sizes of coarse aggregate (especially gravel) and with intermediate sizes removed.

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[1]Hazen: Twenty-fourth Annual Report, State Board of Health of Massachusetts, 1892.

[2]Design of Concrete Mixtures, Bulletin 1, Structural Materials Research Laboratory, Lewis Institute, Chicago, Abrams, 1919. Here Abrams assumes his log scale to start from such a size that when 100 per cent is retained on a size w then

$$\log_2 w - \log_2 .0058 + \tfrac{1}{3} = 0 \text{ or } w = .0041$$

[3]Proportioning Materials of Mortars and Concretes by Surface Areas of Aggregates; *Proceedings* of the American Society for Testing Materials, Vol. VIII, part 2, Edwards, 1918.

[4]A proposed Method of Estimating the Density and Strength of Concrete, etc. Paper before American Society for Testing Materials, Talbot, June, 1921.

[5]See Bureau of Standards Tech. Paper 58, Wig, Williams and Gates, 1916, p. 63 and pp. 38-40.

[6]Official Pub. Ia. State Coll. Agr. & Mech. Arts, Vol. XIX, No. 51, Crum, 1921.

Limiting the Use of Large Cars in France

The seven great trunk lines of France have issued a joint tariff for hauling refrigerator cars whereby all such cars with a tare weight of more than 15,000 kilos will be subject to a surtax of 10 centimes per ton per kilometer in addition to the ordinary freight rates of the merchandise carried. An exception is made with respect to the refrigerator cars of the American army in France which were taken over after the armistice, which are nominally thirty metric tons, as well as other cars of like proportions which may have been put into service previous to July 1, 1920. The effect of this will be an ultimate return to the small sized, lightweight car which is more readily handled in the average freight yard of the French railways. It is believed to be a fact that only at the cold storage warehouse at Marseilles are the long American cars handled advantageously; indeed many freight yards have no turntables big or heavy enough to take them and so they can not be placed at warehouses served only by turntable tracks. Small packages and high costs of handling are still the policy of the French railway.

Layout and Design of Large Modern Freight Terminal

Terminals of Pennsylvania-Detroit R.R. Have Steel Freighthouse with Tracks on Upper Deck—Team Yard at Street Level, but Future Elevation Planned—Outlying Gravity Yard with "Mechanical Hump".

EXTENSIVE additional freight terminal facilities at Detroit, Mich., have been provided in connection with the opening of the new Pennsylvania-Detroit R.R. which extends the Pennsylvania R.R. System to that important industrial center, as described in *Engineering News-Record* of June 29, 1922, p. 1082. These facilities include a city freighthouse and team yard, an outlying team yard, a freight yard with gravity switching and "mechanical hump," an engine terminal and a belt line with numerous interchange and industry connections.

At present, the new city freight terminal consists of a double-deck freighthouse 780x65 ft. with tracks on the upper floor, and an adjacent team yard with tracks at the street level. This freighthouse serves for both inbound and outbound business. It was planned for outbound business only, with a view to the later construction of an inbound house 80x1,060 ft. occupying the greater part of the site of the present team yard and having several floors for warehouse purposes above the track floor. Four of the tracks in this team yard will then be raised to the second floor level, the lower space being utilized as part of the freighthouse.

FIG. 1—SECOND FLOOR OF PENNSYLVANIA R.R. FREIGHTHOUSE AT DETROIT
Elevator shaft on platform. Truss above car has solid filling to form a smoke stop.

This new freight terminal, fronting on Third St., is south of the Fort St. Union Station used by the Pennsylvania R.R. under lease for passenger service. A single track spur on a steel viaduct from the viaduct approach of the Fort St. Station leads into the freighthouse and from this spur an incline track of 3 per cent grade leads down to the team yard. The end of this viaduct at junction with the freighthouse is shown in Fig. 3. When the other freighthouse is built, an inclined driveway from Second St. will give teams access to the elevated team yard. Property for this approach has been secured, south of Congress St. (see Fig. 2). A second team yard has been established already at Summit and Fort Sts., about two miles distant, and this will accommodate the greater part of the team service after the terminal freight station has been enlarged.

Double-Deck Freighthouse—The freighthouse, of steel frame construction, is 780 ft. long, with the main portion 65 ft. wide in the lower floor and 73 ft. for the upper floor, the south side being cantilevered 8 ft. over the adjacent street. This arrangement, shown in Fig. 4, was adopted to economize space and provide adequate width for the track floor, while it also provides shelter over the doorways. This construction continues for about 620 ft., beyond which the width of the first floor reduces gradually to 10 ft., as the house tracks on the second floor converge upon the spur or lead track. At present, outbound business is handled on the north side of the lower floor and inbound business on the south side. The upper floor has a single platform between two pairs of tracks serving for all business.

Steel wall columns spaced 20 ft. c. to c. longitudinally and two lines of intermediate columns carry 48-in. plate-girder floorbeams for the second floor, as shown in Figs. 4 and 5. This spacing was adopted to minimize the spotting of cars to avoid intermediate columns along the second-floor platforms in the proposed future inbound house, as the average length of box cars is approximately 40 ft. over drawheads. On the north side these columns extend upward to carry steel roof trusses, the south ends of which are carried by columns on the cantilever ends of the floorbeams.

A line of longitudinal struts is framed between the trusses on the center line of the building, and diagonal lateral bracing on the top chords is provided in alternate bays. A wide monitor in the roof provides additional light and ventilation. Concrete footings without piles suffice for the foundations. All steel framing is cased with concrete poured in forms, except that the

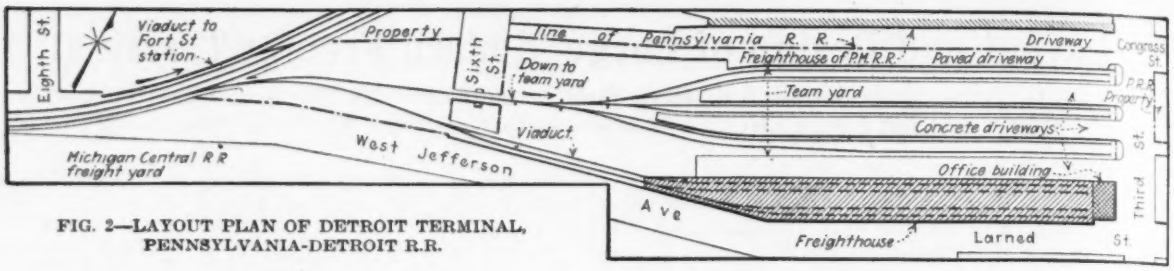


FIG. 2—LAYOUT PLAN OF DETROIT TERMINAL, PENNSYLVANIA-DETROIT R.R.

roof trusses are left bare. In the tapering end of the building there are three and then two lines of columns to carry the second floor.

Walls and Flooring—On both sides of the lower story, doorways 16 ft. wide and 10 to 11 ft. high are located between the wall columns, these openings being fitted with rolling steel doors and having above them a line of steel sash about 6 ft. high. A similar but smaller door is placed in the narrow west end of the first floor. The upper floor has 8-in. brick curtain walls, with piers enclosing the steel columns. These walls are faced with common red brick on the inside and with red rough texture face brick and white terra cotta on the outside. Large windows of steel sash with wire glass are placed in the walls, and have movable pivoted panels for ventilation. Similar sash is used continuously for the 6-ft. sides of the monitor roof, but the entire sash is hinged at the top and is operated in 60-ft. lengths by means of gears and endless hand chains. Exposed concrete is left in its natural color and steelwork is painted gray.

The first floor, served by Larned St. on the south and a concrete paved driveway on the north side, has a solid fill between concrete walls, upon which is laid a 6-in. floor slab of plain concrete. This floor extends slightly beyond the walls to form a fender and is faced with a 10-in. steel channel to protect the concrete from damage by wagons backing up to the freighthouse.

A paving of 2-in. creosoted wood blocks is laid on a bituminous coating on the concrete slab and is grouted with asphalt. Just inside the doorways the floor has a fall of 1 in. to prevent water drifting under the doors and spreading over the freighthouse floor. A transverse firewall of brick divides the lower floor into two equal portions. Three of the roof trusses have an asbestos board filling or curtain to form smoke stops (see Fig. 1). The clear headroom is 16 ft. under the girders in the first floor and 19 ft. from base of rail in the second floor.

For the second floor framing there are 30-in. plate girder struts between the wall columns (see Figs. 4 and 5), and eight lines of 30-in. plate girders framed between the cross girders under the tracks. Upon this framing is a 12-in. reinforced-concrete deck slab, except that the slab is omitted at the middle, its sides supporting the walls of a trucking platform 21 ft. wide. The platform is a 6½-in. slab on joists 20 in. deep and has a 2½-in. flooring. A 3-in. concrete roof slab is supported by 10-in. I-beam purlins and is covered with composition roofing. For live-load, this track deck is designed to carry on each track a 137-ton locomotive of the 2-8-0 type with a driving-wheel spacing of 5 ft. 8 in. and having a load of 24,000 lb. on the truck and 54,000, 57,000, 64,000 and 56,000 lb. on the successive driving axles. The platform is designed for a live-load of 200 lb. per square foot.

Track Construction—Four tracks in pairs 12 ft. and 32½ ft. c. to c. are laid on the second floor, the pairs being separated by the 21-ft. trucking platform. No crossties are used, but the 100-lb. rails on steel tieplates are spiked to creosoted oak blocks 6x8 in. and 30 in. long, spaced 20 in. c. to c.

These blocks are laid on the floor slab and are secured in position by being partly embedded in a concrete surfacing which is given a smooth finish and sloped to form drainage planes. Curves of 418 ft. radius connect the house tracks with the spur track; the turnouts are laid with 18-ft. switch rails and No. 8 frogs. Concrete bumping posts at the stub ends of the tracks enclose steel brackets riveted to the floor framing and are

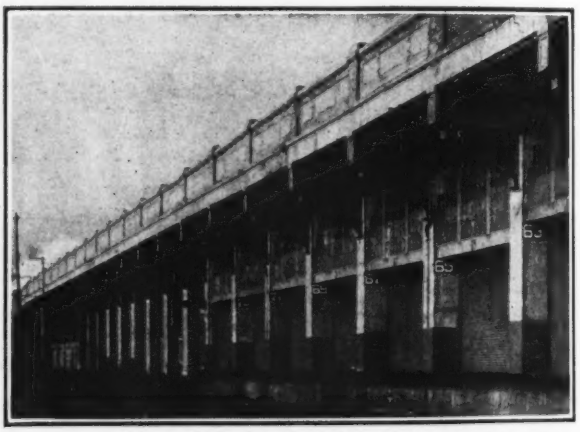


FIG. 3—VIADUCT TRACK APPROACH TO FREIGHTHOUSE
Looking down West Jefferson Ave.

faced with friction draft gears to absorb shock. The four tracks have a total capacity of sixty cars.

Expansion Joints—Expansion joints are provided about 200 ft. apart, with sliding joints in the steel framing. In the roof slab, the 2-in. space is closed by a copper plate embedded in the two slabs and bent in the space between them to form a trough in which a plastic material is filled flush with the top of the composition roofing, which is interrupted at the joint. For the concrete side walls, the 8-in. wall telescopes a socket 5 in. deep in the pier enclosing a steel column, leaving a 2-in. joint. For the brick facing, a line of joints is left without mortar in front of the concrete joint. In the trucking platform of the second floor, the expansion joints are made by embedding 6x6-in. angles in the concrete, with a sliding plate on top, flush with the floor.

Elevators and Tractors—Freight handling between the two floors is provided for by five electric elevators of the automatic type. The vertically sliding shaft gates are also operated automatically, closing before the elevator moves and not opening until it has come

to rest. Four of the elevators are of 5 tons capacity with platforms 9x18 ft. The other, at the outer end of the trucking platform, is of 7½ tons capacity, with a platform 9x30 ft. for handling long and heavy loads. All the elevator shafts are enclosed with brick walls in the lower floor and with heavy steel netting on the upper floor. They are so arranged as to leave a 3-ft. trucking space along the north side of the train platform.

Electric tractors of 2,300 lb. weight are used to haul trains of freight trucks on the lower floor, but on the train platform the trucks are moved by hand. At one end of the first floor is an overhead 5-ton hand-operated traveling crane of 17-ft. span, with runway across the building, for convenience in handling heavy loads to and from wagons. Five platform scales with automatic dials are arranged on the first floor, four being of 3 tons and the other of 6½ tons capacity. Electric flood lighting is provided on the first floor, with lamps of 200 watts spaced 20 ft. apart in three rows. On the second floor there is one row of lamps spaced 20 ft. apart over the center line of the platform. There are attachments also for extension cords to portable lamps in the cars. Drinking fountains are arranged on both floors. The freighthouse has no heating equipment.

A three-story office building, 40x70 ft., forms the street end or main front of the freighthouse. This building is of steel frame construction, with concrete floor slabs, concrete curtain walls, wood floors and brick and terra-cotta finish. Doorways with steel fire doors give access to both floors of the freight house. A basement contains the steam heating plant, telescopic ash elevator, electric transformers and two 3-in. electrically-operated centrifugal pumps for fire purposes. Hydrants with coils of hose are placed adjacent to the elevator shafts on both floors. At the outer end of the first floor is a store room for freight that is held over or not accounted for.

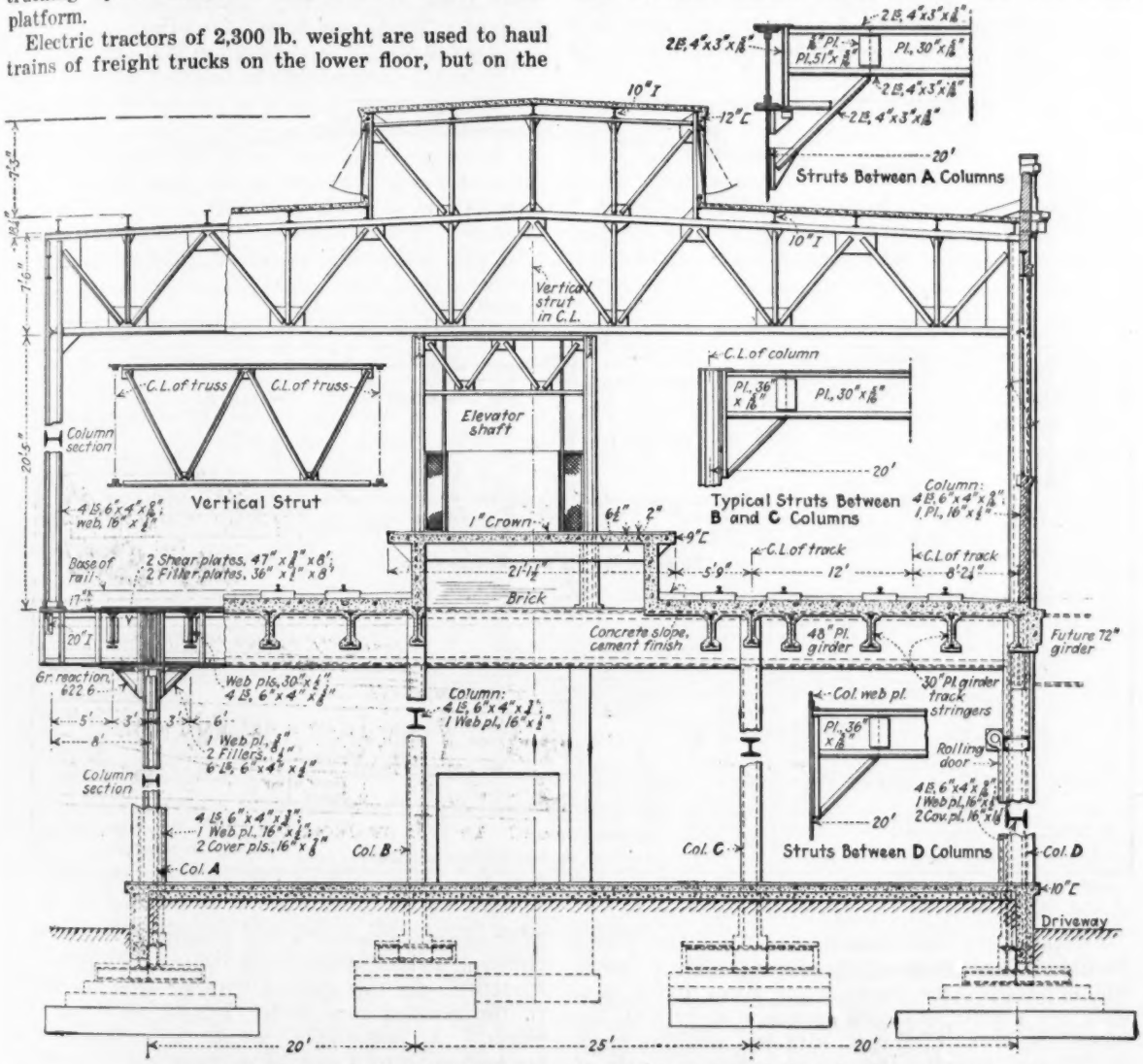


FIG. 4—DOUBLE-DECK FREIGHTHOUSE AT DETROIT; PENNSYLVANIA-DETROIT R.R.

Team Yards—In the adjacent team yard (Fig. 2) there are six tracks spaced alternately 12 ft. and 50 ft. c. to c., with driveways 40 ft. wide between the pairs. These driveways have 9-in. concrete paving; the slabs are crowned 4 in. for drainage, have curbs at the sides and have expansion joints at intervals of 30 ft. The tracks have 85-lb. rails on crossties laid in slag ballast and each is equipped with a friction car stop. The team tracks lead out from the inclined lead track

by curves of 477 ft. radius, with 18-ft. switch rails and No. 8 frogs for the turnouts. The driveways are 700 to 800 ft. long and the six tracks will accommodate about 100 cars.

At the outlying team yard at Summit Ave., already mentioned, the tracks are at right angles to the main line and there is space for trackage sufficient for about 600 cars. The present tracks accommodate 123 cars. For transferring heavy and bulky freight, there is a 25-ton electric gantry crane spanning two tracks and the 40-ft. driveway between them.

one hump. The southbound track over this hump has a 62-ft. 200-ton track scale of the plate fulcrum or flexure type, which does not require a relieving gear for its protection during the occasional passage of locomotives. In this design the extra load does not cause breaking down of the structure forming the fulcrums, as in the case of scales of the knife edge type. The hump track has also very unusual equipment in the form of a "mechanical hump" for adjusting the grades for seasonal conditions, as described in an ensuing article.

Temporary engine handling facilities provided at the

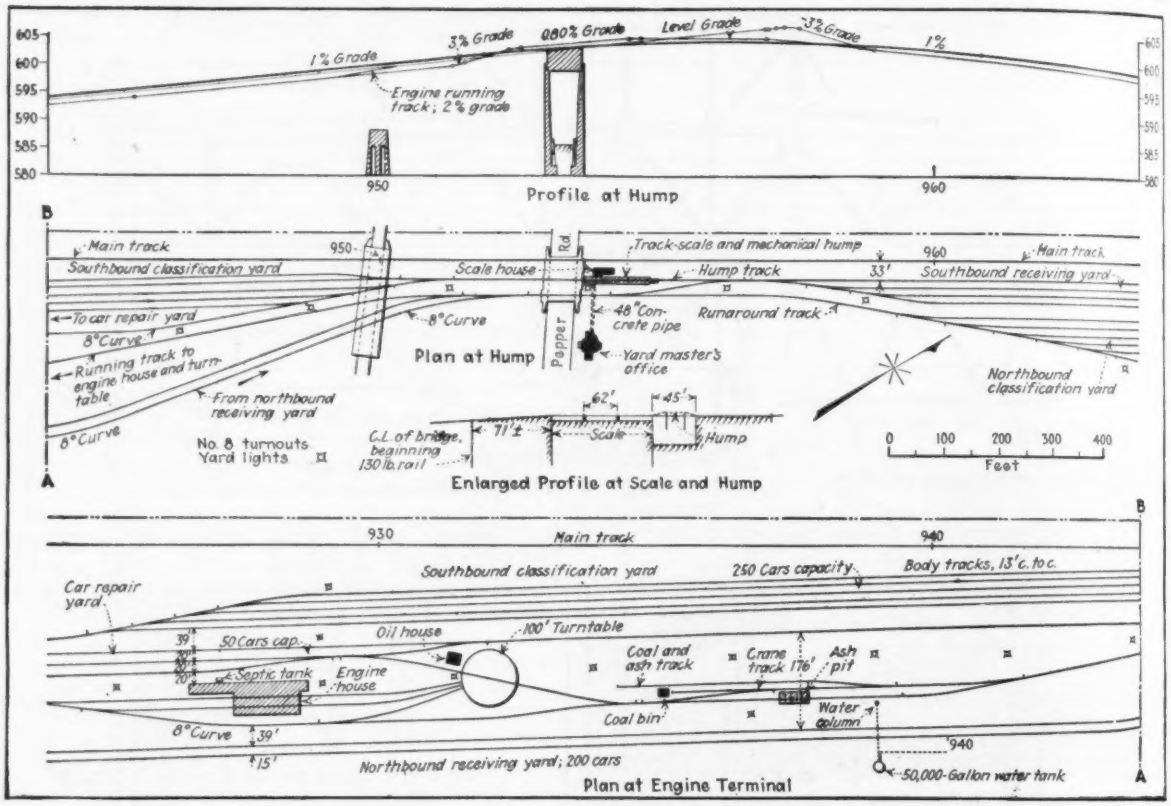


FIG. 6—GRAVITY FREIGHT YARD AND ENGINE TERMINAL

Freight Yard and Engine Terminal—The Ecorse freight yard, about seven miles from the city terminal, will eventually have trackage for about 10,000 cars, with two gravity switching humps. At present, the capacity is about 1,200 cars, with two receiving yards of 200 cars capacity and two classification yards of 250 and 500 cars capacity. The general layout is shown in Fig. 6. All gravity switching is now done over

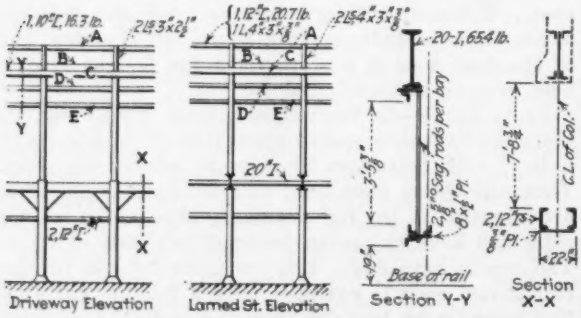


FIG. 7—ARRANGEMENT OF STEEL FRAMING

Ecorse yard, as shown in Fig. 6, include a 100-ft. turntable and a frame double-track rectangular enginehouse 40x120 ft., for two engines, with an extension 20x216 ft. for machine shop, boiler, pumps, office and toilet rooms. A water-filled ashpit and 100-ton coal bin are served by a locomotive crane, and a 50,000-gal. elevated tank serves a single 10-in. water column. Adjacent to the enginehouse is a car repair yard of 50 cars capacity. This engine terminal takes care only of the Ecorse yard engines and road freight engines from Toledo, on which latter all but running repairs are made at the Toledo shops. The Pennsylvania R.R., in conjunction with the Pere Marquette R.R. and the Wabash R.R., has recently completed at 21st St., Detroit, a 28-stall roundhouse with modern facilities to take care of passenger and switching engines.

Engineers and Contractors—These new freight terminals were designed and built under the direction of B. V. Sommerville, chief engineer, Pennsylvania-Detroit R.R. The W. E. Wood Co., Detroit, had the general contract for the freighthouse and the American Bridge Co. fabricated and erected the steel framing.

Strain of Swaying Crowds on Balcony Measured at Iowa

Stress Measurements in Floor Show Load Effect More Than Doubled by Jumping of Excited, Cheering Students

IMPACT measurements on a balcony floor under a crowd of cheering students were made at Iowa State College, Ames, Iowa, two or three years ago to determine what allowances should be made in design of buildings to provide for the load effect of motion due to excitement in a crowd of people. Publication of the results was deferred in the expectation of continuing the experiments, but as no time has been found for the additional tests, the results have now been made available by Prof. A. H. Fuller, professor of civil engineering, who conducted the tests. A large amount of impact test work on bridge floors that has been done since that time gives greater confidence in the impact measurements on building floors.

A general summary of the measurements is given in the table herewith. As will be seen, groups of men numbering from 23 to 95 and weighing from 3,600 to 14,000 lb. were used as the load in the several tests. The test floor was part of the balcony of the college gymnasium, originally built as a running track. Its framing consists of floorbeams of two 8-in. channels projecting out from the walls of the building at right angles to the line of the balcony and supported by a 1⅛-in. hanger rod at the forward end. These beams are spaced 12 to 13 ft. apart and carry timber stringers and a plank floor. Stresses were measured in a hanger rod and in the flanges of a floorbeam. The measurements at these two points are given in the last six columns of the table; the percentages of increased stress, or dynamic effect, are those given in the last and fourth-from-last columns, which it will be seen check each other very closely.

The table includes two sets of measurements, 1-13 and 14-22; they were made about a year apart, by different test parties of students, but will be seen to be quite consistent. All stresses given were measured; i.e. the "Static" stresses were measured while the load was at rest, but they agreed well with calculated stresses.

Mere swaying of a crowd appears to produce moderate impact effects, 10 to 30 per cent. Similar moderate effects occur when a college yell is given "mildly." Vigorous delivery of the yell, which involves considerable jerking of the bodies of the yellers in unison, produces higher impacts, up to 50 per cent. Deliberate rhythmic movement or jumping of the crowd increases these percentages up to 100, 125 or 150 per cent.

Static floor loads ranging from 40 to about 100 lb. were represented by the group of students as arranged on the test area of the floor. The maximum impact percentage of 155 to 165 per cent coincided with the heaviest static load, 116 lb. per sq.ft., giving a static equivalent of total load effect of about 300 lb. per sq.ft. Other high measurements, with static loading of about 90 lb. per sq.ft., represent an equivalent total load of about 200 lb. per sq.ft.

Supplementing the balcony measurements, some stress measurements were made on the main floor of the gymnasium on an occasion when a crowd was assem-

IMPACT MEASUREMENTS ON BALCONY OF COLLEGE GYMNASIUM

Iowa State College, Ames, Iowa; Tests made May 23, 1921, by 1921 Class in Civil Engineering

Test	Kind of Dynamic Load	No. of Observations	No. of Men	Total Weight, Lb.	Floor Area Occupied, Sq.Ft.	Load, Lb. per Sq.Ft.	Stress in Suspension Rod			Stress in Floorbeam		
							Static 1,000 Lb.	Total 1,000 Lb.	Per Cent Dynamic Effect	Static 1,000 Lb.	Total 1,000 Lb.	Per Cent Dynamic Effect
					About	About						
1	Crowd rising on toes and dropping on heels at 2-sec. intervals	10	23	3,637	40	90	...	...	.....	2.75	3.45	25
2	Crowd starts by rising on heels and ends by jumping, 1-sec.	10	23	3,627	40	90	4.5	6.0	35	2.85	5.65	100
3	Crowd rising on toes and dropping on heels, 1-sec. intervals	10	23	3,627	40	90	2.25	3.2	40	2.75	4.8	75
4	Crowd swaying in standing position, ½-sec. intervals	10	23	3,627	40	90	1.1	1.8	70	3.7	5.2	40
5	Crowd teetering on toes, ½-sec. intervals	10	41	6,300	54	116	2.1	5.6	165	5.6	14.2	155
6	Crowd rises from chairs. Floor space entirely filled with chairs	2	41	6,300	163	39	1.9	3.0	50	5.2	7.5	45
7	Crowd teetering on toes, 1-sec. intervals	9	81	12,100	132	92	3.8	5.3	40	9.7	13.2	35
8	Same, followed by jumping	5	81	12,100	132	92	3.8	7.5	100.0	9.7	21.7	125
9	Similar to eight	10	81	12,100	132	92	3.6	6.6	80	9.1	16.2	80
10	Crowd swaying from side to side	10	81	12,100	130	93	3.5	3.8	10	8.4	10.0	20
11	Crowd giving college yell. Standing position	10	81	12,100	...	..	3.5	4.8	40.0	8.4	12.0	45
12	Same	10	81	12,100	....	..	3.1	4.3	40.0	8.2	12.3	50
13	Crowd sitting on chairs, rising suddenly together	2	70	10,500	235	45	2.9	4.5	55.0	6.8	9.2	35
14	Crowd teetering on toes		Crowd gradually collecting				2.2	3.0	35	....	.....	...
15	Same		Crowd gradually collecting				2.7	4.2	55	6.0	9.4	55
16	Crowd jumping mildly		Crowd gradually collecting				3.0	7.5	150	7.5	15.7	110
17	Crowd teetering on toes	11	95	14,250	161	89	3.9	5.1	30	9.9	13.2	35
18	Same	8	95	14,250	161	89	3.9	7.0	80	9.5	21.7	130
19	Crowd cheering: Ames yell	8	95	14,250	161	89	4.2	4.8	15	9.0	11.2	20
20	Same, Locomotive yell, mildly	8	95	14,250	161	89	4.8	5.4	10	9.5	11.0	15
21	Same, vigorously	8	95	14,250	161	89	4.8	7.5	55	9.5	14.0	50
22	Same, Deaf and Dumb yell	8	95	14,250	161	89	3.9	5.3	35	9.0	10.8	20

bling. The framing consists of steel beams supported on columns. The measured stresses were quite low, not exceeding 3,000 or 4,000 lb. per sq.in., and the observed impacts were almost negligible (less than 10 per cent). In this case the movement of the crowd was not in rhythm.

Midyear Population Estimates

Midyear estimates of population, made by the Bureau of the Census on its usual standard arithmetical increase basis, show a total population of 112,078,611 for the whole country and the following totals for some of the larger cities: New York, 6,015,504; Chicago, 2,939,605; Philadelphia, 1,951,076; Cleveland, 912,502; St. Louis, 812,698; Baltimore, 784,938; Boston, 776,783; Pittsburgh, 625,915; San Francisco, 548,284; Buffalo,, 545,273. Eleven cities have risen above 100,000 population since the census of 1920, as follows: Utica, 105,315; Oklahoma City, 103,980; Lynn, 103,693; Tacoma, 103,093; Canton, 102,754; Jacksonville, 102,471; El Paso, 100,264; Schenectady, 100,467; Somerville, Mass., 100,440. There are now 79 cities in the 100,000 plus class. For eight cities no population estimates were attempted because their growth has been such that it is felt they are not properly subject to estimates of population. These were: Detroit, Los Angeles, Seattle, Denver, Akron, Bridgeport, Houston and Spokane.

Calculation of Hydraulic Notch for Channel Control

Method Employed in Designing Channel Construction to Maintain Constant Energy Gradient at Change of Canal Grade

By H. B. Muckleston
Consulting Engineer, Vancouver, B. C.

WATER FLOWING in any open channel which has a constant cross-section in uniform material settles down to steady flow at what may be called normal depth and with normal velocity, that is at the depth and velocity which would be given by the Kutter or any similar formula. If the slope is suddenly increased, the cross-sections remaining the same, the corresponding change in depth and velocity is not sudden but begins a considerable distance upstream from the point of change and ends a great or small distance below it. If the change in slope is sufficiently great the flow may pass through the critical depth at the point of change.

Under these conditions there is a steepening of the energy gradient for a long way upstream with a resultant acceleration and perhaps marked erosion of the bed and banks. As long as the cross-section remains constant this can not be avoided, but by constricting the section at the point of change the energy gradient can be kept up, the surface drop can be confined to a very short length of channel and the erosion largely prevented. If a canal always flowed with the same discharge the calculation of the cross-section at the constriction would be comparatively simple. A plain rectangular notch would serve, and its dimensions would be found by the formulas, $Q^2 \div g = b^5 d_c^3$ and $d_c = \frac{2}{3}E$, where E is the elevation of the energy gradient in the canal under conditions of normal flow.

However, open channels seldom run full at all times but vary widely in discharge. A rectangular notch is suitable for only one value of the discharge. For any higher discharge the canal will head up and for any less discharge there will be a marked acceleration and probably erosion for some distance upstream. If a section could be found which would be just right for all stages in the canal, such a section would be a Hydraulic Notch. The calculation of such a section is not difficult, but is long and very tedious and, considering that the calculated discharges at different depths are approximations at best, there is no particular advantage in determining the exact theoretical section, more especially as a curved section is expensive to construct. A trapezoidal section which is theoretically correct for two selected stages, and nearly so for all others, is comparatively simple of calculation and such a section may for simplicity be called a Hydraulic Notch.

Whatever may be the cross-section of a channel, flow is at the critical depth when $A \div 2T = V^2 \div 2g$, where T is the width at the surface (*Engineering News-Record*, Vol. 85, p. 1034). For any given discharge, if we assume the critical depth (the energy gradient being known), the bottom width and side slopes of a trapezoidal notch are fixed by the above formula as follows:

$$h_v = \frac{V_c^2}{2g} = E - d_c;\ A_c = \frac{Q}{V_c};\ T = \frac{A_c}{2h_v};\ M = \frac{A_c}{d_c}$$

where M is the mean width; $B = 2M - T$, where B is the bottom width, thus all dimensions are known. If we calculate in this way the discharges and the elevations of the energy gradients for two stages in any given canal it is possible to select from the infinity of notches which will satisfy either condition one section which will satisfy both.

In the following example the calculation is for the control section at the head of a chute which forms the tail-out for an earth canal 20 ft. in bed width, side slopes 1½ to 1, graded on a slope of 0.0004. Selecting two stages of 3.0 and 4.0 depth and calculating by Manning's formula,

$$d_1 = 4.0;\quad Q_1 = 258;\quad E = 4.095$$
$$d_2 = 3.0;\quad Q_2 = 156;\quad E = 3.070$$

a series of notches are worked out for these two stages as shown in the table herewith. This calculation is much less formidable than it looks. The whole table was worked out in 16 minutes with a duplex slide rule using only 13 settings. (Lest the writer be accused of splitting hairs, it may be explained that the third decimal place is due to the use of a 20-in. rule.)

If the series of notches for the upper stage is plotted one over the other a curve can be drawn tangent to the sides of all of them. Similarly a curve can be drawn for the series at the lower stage, and a line tangent to both curves is evidently the side of the required notch. It is well to plot to a fairly large scale —2 in. to 1 ft. is not too large—as the curves are much more easily drawn. In this case the required notch has $B = 7.54$ with a side at 0.90 horizontal to 1.0 vertical.

A very similar problem arises in connection with flumes and more especially with inverted siphons. To save expense, flumes, especially long flumes, are usually built to much steeper grades and for far higher velocities than canals. At the transition from canal to flume there must be an acceleration of the water with a corresponding drop in the surface. For any one stage in the canal it is not difficult to prevent this acceleration from doing any damage to the canal but when varying stages are considered the problem is not so easy. If the flume design is such that the water flows at or below the critical depth at all stages in the canal the problem of the control is the same as above, but this is seldom the case. Usually the flume flows above the critical depth for all stages and the design of a control section is not easy and consequently is usually not really attempted, reliance being placed on protecting the bed and banks for some distance upstream, generally as taught by experience. This may be the cheaper method or it may not. The trouble is that it is quite impossible to foretell how far upstream protection will be needed; if too much is provided it will never be known, while if too little is given the fact is apparent at once. The cost of a proper transition section can be estimated quite closely in advance, whereas the cost of protection, which is adequate and no more, can only be guessed at.

In the case of an inverted siphon the matter is worse; pipes always run full no matter what the quantity. As a consequence the friction head varies through a wide range for varying stages in the canal and, as this variation always integrates at the upstream end, there may be an actual fall into the pipe when the canal is at low stages.

In either case the simplest solution is to provide

a hydraulic notch at a point above the entrance to the flume or siphon. The notch is an absolute control for the canal and whatever in reason may happen below the notch will have little or no effect on behavior of the water above. On the downstream side of the notch a suitable transition section may be designed which will allow either acceleration or retardation of the water as required. The energy lost in the double process of acceleration into the notch and retardation or further acceleration into the flume or siphon need not be great enough materially to affect the size of the conduit below.

As an example assume that the canal above considered discharges into a rectangular flume 10 ft. 9 in. wide on a gradient which for the upper stage would result in a velocity of 8.02 with a depth of 2.99. This is just above the critical depth for a rectangular channel for the upper stage as shown in the accompanying table. The energy gradient at entry will be 4.095, the velocity head in the flume is 1.0, or a total of 3.99, leaving 0.105 for energy lost in the transition, which should be sufficient if properly designed. If only one stage in the canal above had to be considered a warped transition would be sufficient. But then what would be the condition when the canal was at the lower stage? With the discharge of 156 the flume would run about 2.1 ft. deep. The velocity would be about 6.7 and the velocity head about 0.7, making the energy gradient about 2.8. As the energy grade in the canal is 3.07 for this stage there is a loss in energy head of 0.27. Loss in transition might account for perhaps 0.07, leaving 0.2 to be dissipated somewhere in the canal above, which might be quite enough to cause scour for several hundred feet upstream.

If a hydraulic notch is interposed between the canal and the flume it will be an absolute control for the canal preventing dangerous acceleration at all stages, and the transition between the notch and the flume might be a simple warped section which need not be very long or very expensive, and if carefully designed need not involve any great loss of energy.

The example given is not extreme. A more probable section for the flume would be narrower and deeper, say 8 ft., wide by 4 ft. deep which would mean that the floor of the flume must be about 1 ft. lower than the canal bottom in order to provide the acceleration and entry heads. For the lower stage the depth in the flume would be about 3.0, the velocity head about 0.7, total 3.70. From this must be deducted 1.0 for the difference in level, leaving 2.70 for the elevation of the energy gradient above canal bottom; which indicates a loss of 0.30, much worse than the first case.

TABLE ILLUSTRATING HYDRAULIC NOTCH CALCULATION

Stage	Q	E	dc	$h_e = E - \frac{3}{2} dc$	$Ve = \sqrt{2 h_e}$	$Ae = \frac{Q}{Ve}$	$T = \frac{A}{2 h_c}$	$M = \frac{A_c}{d_c}$	$B = 2M - T$	
1	258	4.095	2.73	1.356	9.37	27.52	10.15	10.15	10.15	Rectangular Sec
..	...	.....	2.80	1.295	9.12	28.27	10.92	10.10	9.28	
..	...	.....	3.00	1.095	8.40	30.70	14.02	10.23	6.44	
..	...	.....	3.10	.995	8.00	32.25	16.21	10.40	4.59	
..	...	.....	3.20	.895	7.59	34.00	19.02	10.64	2.26	
2	156	3.07	2.04	1.03	8.14	19.16	9.31	9.31	9.31	Rectangular Sec.
..	...	.....	2.10	.97	7.90	19.74	10.17	9.40	8.63	
..	...	.....	2.20	.87	7.48	20.84	11.98	9.47	6.96	
..	...	.....	2.30	.77	7.03	22.20	14.42	9.65	4.88	
..	...	.....	2.40	.67	6.56	23.79	17.74	9.82	1.90	

Pipe Break Undermines Settling Basin Wall at Fort Collins, Colo.

FAILURE on July 4 of a wood-stave pipe line passing through the wall footings of the continuous-flow 2,000,000-gal. settling basin of the Fort Collins (Colo.) water-works undermined the otherwise undamaged wall and released the 1,500,000 gal. of stored water. The rush of water damaged 20 ft. of wood-stave pipe line leading to the filters but the line was repaired the same day, permitting a resumption of filter operation. A portion of a storage room and a few sacks of alum were lost, the total damage not exceeding $1,500, according to E. A. Lawver, city engineer, who describes the accident as follows:

The walls of the basin consist of thin slabs of concrete supported by counterforts on 10-ft. centers, all resting on a substantial footing. The walls are backed by an earth bank. Although the plans called for a concrete floor, none was poured because of the shortage of funds. The soil was found to be very impervious and as the footings were carried well down it was believed that the basin could be used without a concrete floor until funds were available. Continued use of the basin has born out this belief, as very little seepage has occurred.

The basin is supplied by a 22-in. wood-stave pipe line built a number of years ago. It passes longitudinally through the basin and through the footings. Valves and regulating wells are so arranged that the water may be sent directly to the filters without going through the basin. The same wood pipe delivers water to the filters when the settling basin is in operation.

It has been the intention to replace this pipe with a concrete conduit at the time the concrete floor is laid. For a safety measure, the pipe was rebanded where it was to pass through the wall and earth bank before the basin was built. From all appearances, it was this pipe that failed. Apparently a section of the wood-stave pipe blew out beneath the bank and immediately next to the footing, causing a whirl of water to wash under the footing and the basin floor.

No damage was done to the wall which did not show any sign of failure although 16 ft. of the footing was entirely undermined. One of the regulating wells is attached to and is a part of the wall at this point, and even though entirely undermined it showed no signs of cracking or pulling away from the main part of the wall.

Repairs on the basin were begun immediately. Gravel had to be hauled eight miles and all supplies sixteen. Nevertheless, by the evening of July 8 the hole under the footing and regulating wall had been cleaned out and filled with concrete and a cutoff wall poured the entire 90-ft. length of the downstream side. This work put the basin in as good condition as it was before the accident, but as a precautionary measure, part of the basin floor is being poured with cutoff walls where the floor is to end. In addition, the wood-stave pipe is being rebanded and inclosed in a 12-in. layer of concrete. It was expected that this work would be completed by July 23 and water turned in by Aug. 1. The contemplated work requires about 500 cu.yd. of concrete.

Letters to the Editor

This department aims to be a forum for the discussion of the views of engineers and contractors. The range of interest should be as wide as possible. Contributors are, therefore, asked to make their letters short.

"Constructor" for "Contractor"

Sir—In a letter from a prominent highway builder, recently published, the question was asked: "Why is the constructor heralded by the papers as a profiteer, grafter, etc., when he organizes?" The answer to that question, and thers asked by our fellow craftsman, is stated to be "lack of that degree of organization which would bring us collectively a reputation for skill, integrity and responsibility, and give prestige, influence and favor."

Our contributor's challenge presents an opportunity for again asking attention to the necessity for bringing the word "constructor" into general use for designating a general contractor who undertakes the execution of engineering and architectural projects. As matters exist, the producer or vendor of embalmed beef, beds, buttons, or what not, is known to the world generally not as a contractor, but by a terminology peculiar to the industry in which he is engaged. Whenever, however, such species assume specific contracts with a public body and become malefactors in connection therewith, they are immediately certified to the country at large, through all news agencies, as "wealthy contractors," dishonest and seeking to defraud. The monuments of Memphis, erected in the dim dawn of civilization, depict the punishment of a dishonest contractor but do not state whether he was a constructor or a purveyor of pumps. Incidentally, and notwithstanding the fact that government statistics show that less than one constructor out of twenty is ultimately successful in business, it is no less astonishing than ludicrous how the word "wealthy" has become associated with the craft.

By such inferences the constructor is constantly loaded with a reputation for iniquity and profits far beyond the scope of his activities or performances. He is indirectly forced to carry the burden, in the public mind, not only of his own shortcomings but those of a multitude of other contractors who have no relation whatever to him or oftentimes to the construction industry.

Irrespective of other reasons which could be cited, does not the foregoing constitute ample grounds for a surgical operation on the English language and the binding thereon of the word "constructor?" Is it not a fact that until general contractors everywhere insist upon consistently using and designating themselves by the word "constructor" such operation cannot be successfully performed or lasting results accomplished?

HENRY H. WILSON,
Chairman, Associated Pennsylvania Constructors.

Harrisburg, Pa.
Aug. 2, 1924.

Repairing Break in Submerged Water Main Due to Bridge Accident

Sir—I note in the "News of the Week" of your issue of July 17, p. 115, an account of the breaking of the counterweight of the bascule bridge crossing Coney Island Creek on the line of Harway Ave., Brooklyn, N. Y., in which it is stated that no serious results attended the accident to this structure. Whether this be a correct statement or not depends upon the interpretation of the word "serious."

The counterweight, which I understand weighs about 20 tons, struck in the mud directly over a 20-in. flexible-joint cast-iron water main that was laid 19 years ago, and at this point was about 4 or 5 ft. below the muck level, and approximately 8 or 10 ft. below the water level at high tide. The weight broke the water main, the break occurring at about 1 p.m. on Thursday, July 10. The broken main is one of five mains feeding Coney Island, and is the one through which the greatest flow normally takes place. The pressure on the Island during the summer period in the daylight hours is about 30 lb. per square inch, and the break caused a drop in pressure of varying amounts, depending upon the time of day, but in general during the daylight hours of 10 lb. per square inch. This caused what we considered a dangerous reduction in the supply to Coney Island.

A survey of the situation quickly made on the afternoon of the break showed that until the bridge was opened suitable equipment could not be brought into place to repair the line, that the repairs to the line would be problematical as to the time required, and that the only hope of quick relief lay in the installation of a temporary line across the creek. The width of the creek at this point is about 200 ft. and the channelway at the lift bridge about 50 ft., with a depth at high tide of approximately 10 ft.

Arrangements were immediately made to install a temporary 16-in. iron pipe across the creek, and Allen N. Spooner & Sons, Inc., were directed to obtain the pipe, drive the necessary piles, and to lay the pipe, the department arranging through its own force and other contractors to install some 350 ft. of cast-iron bell-and-spigot pipe on the two shore ends. Owing to the presence of a derrick which lifted the counterweight from the creek bed, our contractor was unable to do any work on the southerly side of the creek until after 4 a.m. Saturday morning. He then drove the piles for the southerly portion of the crossing, having already driven the piles for the northerly part. The three lengths of pipe forming the horizontal section were laid together on the bridge, together with the two 45 deg. bends and two lengths of pipe that would bring the top of the pipe above the water level. A 70-ft. 12 x 12-in. timber was used to stiffen this pipe and make a temporary trussed section so that the entire section was lifted by the derrick and put in position. This pipe was in position about 8 a.m. Saturday, and the entire line was completed, blown out, chlorinated, and ready to put in service by 4 a.m. July 13 (Sunday).

I believe that from the foregoing you will agree with us in our conclusion that serious results did attend this accident, and that such results called for rather unusual action on our part in maintaining an adequate water supply for Coney Island.

WILLIAM W. BRUSH,
Deputy Chief Engineer, Department of Water Supply.

New York, July 28.

Activated-Sludge Plant For Hagerstown, Md.

An activated-sludge plant with a capacity of 3 m.g.d. is being built by Hagerstown, Md. Inasmuch as the flow of Antietam Creek into which the effluent will be discharged ranges from about 8 m.g.d. or less in summer to some 40 m.g.d. in winter, it is the plan to operate the works as an activated-sludge plant during periods of low flow and as a plain sedimentation plant when there is sufficient dilution to prevent a nuisance. Information supplied to *Engineering News-Record* by Abel Wolman, chief engineer, Maryland Department of Health, indicates that the work will consist of coarse bar screens, entirely covered to prevent possible nuisance, a fine Dorrco screen designed to lessen the load on the aeration units, a grit chamber as a further relief to the aerators, activated-sludge tanks and settling tanks equipped with Dorr thickeners. Whether an air or a mechanical agitation system will be used has not yet been decided. The design and construction of the plant is in the direct charge of J. B. Ferguson, chief engineer of the Hagerstown Sewerage Commission. It is understood that C. Lee Peck has been consulted on various features of the design of the plant. Construction work has been delayed by a serious accident which befell Mr. Ferguson late in June. It is expected that the plant will be in operation by the end of this year.

News of the Week

CURRENT EVENTS IN THE CIVIL ENGINEERING AND CONTRACTING FIELDS

News Brevities

In View of the Fact that the next session of Congress is expected to authorize the taking over of the Cape Cod Canal, some attention is being given to the needs of the waterway by way of improvement. The big question involved is whether the open channel is to be maintained or whether a tide lock is to be constructed. There are objections to the lock because of the delay to commerce incident to its operation. The prospects are that the channel will be widened to 200 ft. and dredged to a uniform depth of 30 ft. At present the channel is 60 ft. wide and 25 ft. deep. Even under these conditions it is being used by some 8,000 vessels annually.

Major Wm. E. R. Covell, the new assistant engineer commissioner for the District of Columbia, will devote practically his entire time to public-utility problems. The increasing amount of work in the relationship between the District government and the public utilities companies has made this change of policy necessary. A bill which all but became a law at the last session of Congress, providing for the addition of an engineer and an attorney to the membership of the Public Utilities Commission, is expected to pass early in the coming session.

During July the Corps of Engineers added 55,000 cu.yd. to the total of the concrete work in the Wilson dam. While as much as 73,000 cu.yd. had been put in in a single month in the course of the work on the Wilson dam, the July total exceeds that of June by nearly 15,000 yds. The pool above the dam now has been raised to a point 50 ft. above the low-water level of the stream. As the water rises close watch is maintained so that any leak may be discovered immediately. The limestone in that area is honeycombed with caverns but no leakage has developed at the present level of the pool.

Approximately $48,000 has been raised in Kentucky and $55,000 outside of Kentucky for the improvement of a direct Chicago-to-Florida highway route. The route chosen after considerable thought is a Dixie Highway link. Cincinnati has pledged $25,000, Detroit $10,000 and Chicago and Indianapolis are now considering means of raising another $25,000. In Chicago, the campaign to raise these funds has been placed in the hands of the Chicago Association of Commerce's good roads committee, though the actual raising of the funds will be done by a committee not acting directly in the name of the association. The good roads committee of the association is headed by W. W. DeBerard, western editor, *Engineering News-Record.*

A.A.E. Re-Establishes Offices in Washington

The Washington office of the American Association of Engineers was re-established on new lines and offices were opened July 15 at 712 Investment Building, 15th and K Streets, Washington, D. C. in charge of A. B. McDaniel. The Association hopes to become of considerable usefulness as a fact-finding or research service and to help in the articulation of business, politics and engineering.

A few topics of national interest and importance to engineers will be selected after canvassing the chapters. It is expected that among these topics will be: A federal bureau of public works; thrift and economy in federal administration; development of land and water resources; bureau of domestic commerce; allocation of patent office to the department of commerce.

Each chapter has been asked to appoint a committee to be in position to gather data and report on national topics. The Washington office will also continue the drafting of specifications for engineering positions in branches of the profession determined by canvass of the membership.

License To Develop Santee and Cooper River Power Issued

The Federal Power Commission has authorized the issuance of a license to the Columbia Railway and Navigation Co., to whom a preliminary permit was issued Sept. 20, 1921, covering the project on the Santee and Cooper Rivers. The project contemplates the construction of a diversion dam in the Santee at Ferguson, the digging of a 14-mile canal easterly into the basin at the head of Cooper River, the construction of three or more earthen dams to create an equalizing reservoir and the construction of a power house and tail-race discharging into Cooper River at a point 25 miles above Charleston, S. C.

The development will be made in two stages. In the first stage the water will be impounded to a level of 55 ft. above sea-level and in the second stage the dams will be raised 10 ft. It is estimated that 42,000 hp. can be developed initially and 122,000 hp. ultimately. The Foundation Co., of New York, has undertaken to finance and construct the project.

In connection with this development the Lexington Water Power Co., which has behind it the same interests as those comprising the Columbia Railway and Navigation Co., has applied for a license to construct a dam 100 ft. high in the Saluda River near Lexington, S. C. The reservoir to be created would store 12,000,000,000 cu.ft. of water. This project would be tied in with the Santee-Cooper project.

Two Railways Plan Extensions to New Gold Fields

Plans for the extension of the Kirkland Lake Branch of the Temiskaming & Northern Ontario Ry. from Larder Lake eastward for 37 miles into the Rouyn gold fields of Quebec have been announced by the Ontario Government. As the T. & N. O. Railway is owned by the Ontario government and as the last thirty miles of this projected extension are within the province of Quebec, it was necessary to obtain the sanction of the federal government for this extension. It is expected that the Kirkland Lake Branch will be completed as far as Larder Lake this fall, and a location line will be run from there to the Rouyn gold fields so that construction can be started as soon as the value of the new gold fields is confirmed. The estimated cost of the new line is $1,500,000.

Meanwhile it is expected that at the official opening of the extension of the Interprovincial & James Bay Ry. from near Temiskaming to Angliers, Que., an announcement will be made of plans to extend the line on to the Rouyn gold fields, a distance of about 50 miles. The Interprovincial & James Bay Ry. is a colonization railway, financed, in a large part, by the Quebec government, and built by the C. P. Ry. Passenger service from the present end-of-steel to the Rouyn gold fields is now rendered by a combined automobile and boat line, and by hydroplane.

Plans Under Way for Third Sewage Works for Cleveland

Steps have been taken by the city of Cleveland, Ohio, to build the southerly sewage-works, which will be the third and last one of the three plants projected some years ago to treat the entire sewage of the city. The city has engaged George B. Gascoigne, consulting sanitary engineer, Cleveland, to make a preliminary report on the project, design the works, superintend construction, and place the plant in operation.

The work will all be done in Mr. Gascoigne's office under the general direction of W. S. Ferguson, director of public service, and Robert Hoffmann, commissioner of engineering. The two existing sewage-works of Cleveland were designed and built under the direction of Mr. Gascoigne while he was city sanitary engineer of Cleveland. In the new work undertaken by Mr. Gascoigne, assistance will be rendered by W. L. Havens, A. A. Burger, F. W. Jones, and M. F. Stein, all of whom were associated with Mr. Gascoigne as assistant engineers in the design and construction of the two plants already built. The estimated cost of the southerly plant is $3,000,000.

Old Highway Bridge Collapses at Dayton, Ohio

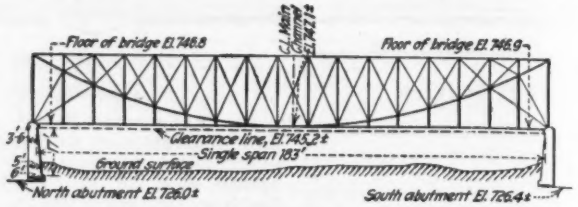
Special Correspondence

A single span highway bridge over Wolf Creek at Summit St., Dayton, Ohio, collapsed and dropped into the creek bed on the afternoon of July 24. Two loaded trucks and a Ford coupé, as well as two pedestrians, were on the bridge at the time and all dropped with the bridge. Seven persons were injured though none seriously.

The bridge was built of pin-connected trusses of the inverted bow-string type, supported on vertical Phoenix type end posts. The clear span was 183 ft.—17 panels of approximately 11 ft. each. The width between trusses was 18 ft. and the clear roadway about 16 ft. Wooden sidewalks were built on each side on the outside of the trusses. The bridge floor was of the usual plank type supported on steel floorbeams and stringers.

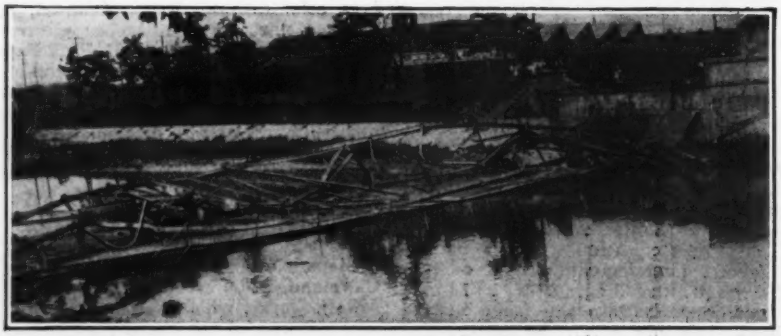
As nearly as can be ascertained this bridge was fabricated in the early eighties by J. H. and C. C. Morris and was originally erected at Main St., Dayton, where it formed one span of the bridge across the Miami River at that point. In 1904 the Main St. bridge was torn down and replaced by a concrete structure. Two or three years later the span referred to was re-erected at Summit St., across Wolf Creek. The bridge shows signs of lack of maintenance, some of the floorbeams being badly pitted with rust.

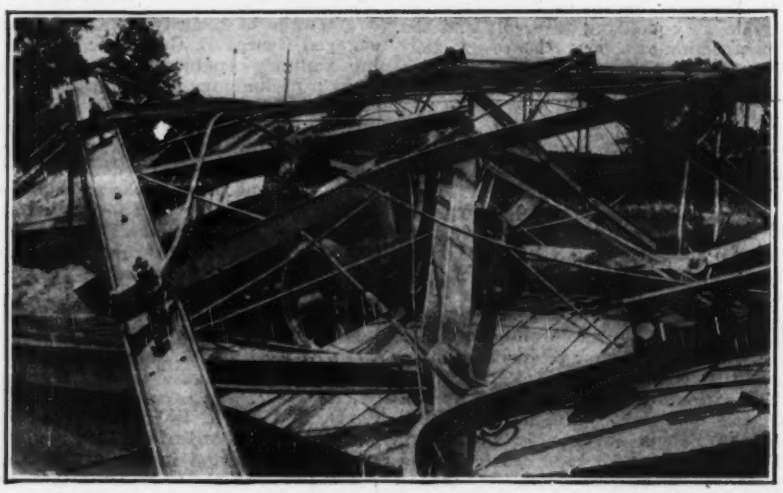
At the time of the collapse a 5-ton truck loaded with 4 or 5 cu. yd. of wet gravel was about two-thirds of the way across the bridge and on the downstream side. Some 60 ft. behind this truck was another smaller one proceeding in the same direction and loaded with 2 tons of coal. Coming in the opposite direction a Ford coupé had just driven onto the bridge when the collapse occurred. There were few witnesses and it was not possible to get a definite statement as to just how and at what point the failure first occurred. The floor remained practically intact as the bridge settled to the creek bed and the trusses crumpled and fell upstream. The gravel truck evidently struck one of the vertical members as the bridge fell, as the front end of this truck projected onto the sidewalk on the downstream side. Neither truck turned over.



DETAILS OF THE WOLF CREEK BRIDGE, DAYTON, OHIO

FLOORBEAM PITTED BY RUST





COLLAPSED WOLF CREEK BRIDGE. ABOVE—POSITION OF TWO TRUCKS. BELOW—CLOSE UP OF TRUSS NEAR GRAVEL TRUCK

Although signs had been posted at both ends of the bridge limiting the load to 6 tons, it is reported that trucks similar to the large one on the bridge at the time of the collapse had been using the bridge for several days carrying gravel to a nearby concrete job.

The city of Dayton has engaged the firm of Harrington, Howard & Ash, of Kansas City, to make a complete investigation of the failure, and this investigation is now under way.

Bankers Pledge Million for Rebuilding of Lorain

A committee of Ohio bankers has pledged $1,000,000 for the rehabilitation of Lorain, badly damaged by a tornado on June 22. Harris Creech, president of the Cleveland Trust Co., outlined the plan of raising the funds to sixty bankers of the state, meeting at the call of Governor Donahey in Columbus. It was unanimously adopted. Under the plan a non-profit sharing corporation is to be formed to lend money on secured mortgages where the property mortgaged is not of sufficient value to obtain enough money through regular channels to rebuild destroyed property. A committee of fifteen bankers will be appointed to incorparate the company and from this number five will be selected as directors. The directors will pass on all loans, upon which a 6 per cent interest charge will be collected.

Civil Service Examinations

UNITED STATES

For the following civil service examination apply to the Civil Service Commission, Washington, D. C., or to any office of the Commission.

Dynamometer Engineer—Vacancy in the Bureau of Mines, San Francisco, Calif., the duties requiring that the appointee be a skilled engineer with ability to assemble properly, set for tests and operate internal combustion engines, and requiring a thorough knowledge of thermodynamics. Salary $3,800 a year with possibility of advancement to $5,000.

Receipt of applications for the position will close Sept. 2.

Replanning Central Part of Philadelphia

Nine Principal Features Included in Program Planned for Improving City Hall Vicinity

The first tangible steps toward the replanning of central Philadelphia have been made by the submission by the City to the Pennsylvania Railroad of plans for changes at City Hall Square and west to the present West Philadelphia station of the railroad, involving the construction of a new station on the west bank of the Schuylkill River. The plans were developed by the city engineers, working in co-operation with the engineers of the Philadelphia Rapid Transit Co.

The plans involve nine principal features: (1) Construction of a new terminal by the Pennsylvania R.R. to be located between the Schuylkill River and the present West Philadelphia station; (2) elimination of the elevated tracks of the Pennsylvania R.R. from Broad Street Station west to the river, and the construction of underground trackage in place of them; (3) construction of an underground station at about Fifteenth St. for the suburban train service of the Pennsylvania R.R.; (4) widening Fifteenth St. between Arch and Chestnut Sts.; (5) widening of Filbert St. from Broad St. to the Schuylkill River to make it an 80-ft. boulevard; (6) construction of tangent tracks for the Market St. subway through City Hall; (7) construction of a foot concourse under City Hall, in the tunnel now used by the Market St. subway tracks; (8) construction of a "subway street" under Broad St., from Cherry St. to Walnut St. connecting with the underground concourse under City Hall; (9) construction of a boulevard along the west bank of the Schuylkill River from Spring Garden St. to South St.

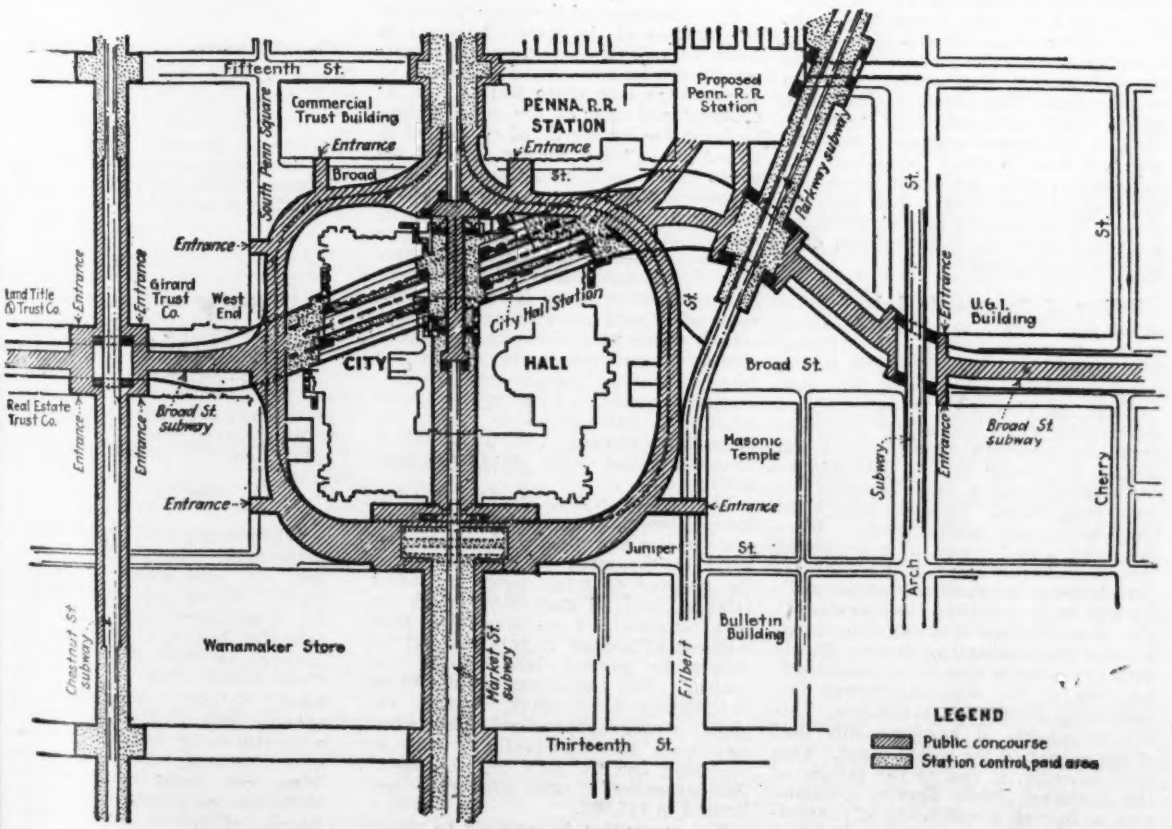
These plans constitute the first formal step in the program started recently by the mayor with the naming of a committee to study and co-ordinate plans for improving the city. The committee comprises Samuel Rea, W. W. Atterbury, and E. B. Temple of the Pennsylvania R.R., Eli Kirk Price of the Fairmount Park Commission, Solomon M. Swaab, city consulting engineer, Joseph P. Gaffney, city solicitor, Charles B. Hall president of city council and Mayor W. Freeland Kendrick. The plans presented to the railroad representatives were worked out by the engineers of the Department of City Transit and Mr. Swaab, in consultation with Philadelphia Rapid Transit engineers.

Pennsylvania R.R. men have expressed their satisfaction with the proposed changes in the railroad, but declare that the company is not just now ready to undertake the financing of the project.

Train-Control Order Modified

Enginemen may, if alert, forestall the application of the brakes by an automatic train-stop device and control their train in the usual manner in accordance with hand signals or train order, as a result of the recent order of the Interstate Commerce Commission modifying its two previous orders concerning the installation of automatic train-control or train-stop on one or more divisions of the larger railroads of the country. At the same time the commission suspended, until further orders, the date upon which the installation of train-control on 42 of the roads mentioned in its second order shall be completed. The commission declined to extend the time for completion of the installations on one division each of the 49 railroads mentioned in its original order. The net result of the recent order is that the 49 railroads mentioned in the first order are required to have one division equipped with train-control by Jan. 1, 1925, and 47 of them must have two divisions equipped by Feb. 1, 1926.

The use of the so-called permissive feature was expressly forbidden in the original order, but the testimony at the recent hearing in favor of using it was so conclusive that the commission decided to permit its use. It makes possible the elimination of many of the objectional features of automatic train-stop from an operating standpoint.



CITY HALL AREA OF PHILADELPHIA SHOWING CHANGES INVOLVED IN REPLANNING SCHEME

Washington Notes

Action on the Part of the Rock Creek Power Co., of Missoula, Mont., in beginning a small amount of construction work on the eve of the expiration of its license covering a small project on Rock Creek in Western Montana, has raised the question at the Federal Power Commission as to how such situations can be met. If construction work is not begun before the expiration of time fixed in the license, the license can be revoked by a simple written order from the Commission, but when construction work actually has begun, the license only can be revoked through court proceedings. From a legal point of view, it seems that the licensee will have complied with the letter of the law if he makes a few scratches on the project. While advantage may be taken of the law in this regard, the feeling at the Commission is that a change in the law is unnecessary since the licensee is throwing away a portion of the time allowed for completion. It will be possible for the Commission to terminate the license on the latter date. If another applicant who is prepared to make the development promptly should appear, an injunction could at that time be sought.

The Injunction Sought This Week in the Federal Court of the Southern District of Georgia against the project of the Georgia-Alabama Power Co. in the Flint River near Albany, Go. is in compliance with a request made by the Federal Power Commission eighteen months ago. The Chief of Engineers, acting on a declaration of intention filed by the power company, held the proposed dam to affect navigation. In compliance with his recommendation the Federal Government took jurisdiction. The power company's contention is understood to be that the dam does not affect navigation.

Failure of Congress to Take definite action with regard to Muscle Shoals is certain to result in delay in utilizing the power after the dam and power house have been completed, it is pointed out. If the Ford offer is rejected, an alternative would be to call for bids from the southern power companies. Before the power can be delivered to any one of them a large transformer must be installed. This will have to be built to special specifications. Were the order placed today, it is contended that it could not be ready for June 15, 1925, when it is expected that the project will be in a position to operate. It also is pointed out that the only transmission line connecting Muscle Shoals with any outside system is the 30,000-kw. line of the Alabama Power Co., connecting Sheffield with Cordova. This line is capable of handling only half of the output of the steam plant. This fact, however, is due to the failure of the Alabama Public Service Commission to furnish a certificate of convenience and necessity which the Alabama Power Co. has been insisting upon for two years.

Liberty Tunnel Ventilators Given Emergency Test

The ventilating system of the Liberty Tunnels, Pittsburgh, successfully met an emergency test on July 30 when a motor truck caught fire about three-fourths of the way in from the Brownsville Ave. entrance. The tunnel was cleared of the dense smoke resulting from the fire in three minutes after the power plant had been notified of the fire. The ventilating plant is undergoing a 30-day test prior to its final acceptance by Allegheny County, and A. D. Neeld, chief engineer of the tunnel, writes that the plant "met all of the requirements providing for a full supply of fresh air for those using the tunnel at the time."

N. Y. State Committee to Study Oil and Sewage Pollution

Acting in accordance with a joint resolution of the New York Legislature, the presiding officers of the two branches of that body have announced the appointment of members of a committee to act jointly with undesignated officials of the states of New Jersey and Connecticut in devising ways and means of minimizing the pollution by oil and sewage of the waters adjacent to the three states, and also to investigate sewage disposal generally throughout New York State. The committee consists of two senators and three members of the Assembly, all of New York City.

The whereases of the resolution refer to pollution of the waters adjacent to New York, New Jersey, and Connecticut by the long-continued discharge of city sewage into those waters, the increasing pollution of the same waters by " the use by vessels of oil as fuel in recent years," and declare that on account of this sewage and oil pollution a condition has arisen which "constitutes a peril to the health of the community and a menace to human life to such an extent as to cause public concern if not public alarm." The resolution proper provides for the appointment of a joint committee, as already stated, which in addition to the duties already mentioned is to enable the three states to "jointly urge the federal government to take such measures within its jurisdiction as would be proper to remedy the pollution of waters adjacent to the state by sewage and by oil."

The resolution also provides that the "committee may also examine the sewage systems and method of sewage disposal in the cities of this state for the *purpose of modernizing the same* [Italics ours], of suggesting plans for such purpose and recommending such methods of sewage disposal as may be proper to protect human life and health." The committee is empowered to "employ a secretary, counsel, experts, stenographers, and such other employees and assistants as may be necessary and fix their compensation." The expenses of the committee are limited to $25,000.

The committee is required to report to the legislature on or before March 1, 1925.

Random Lines

Or in Sugar, Perhaps

A silica company the other day sent us a small sack of the finest, cleanest sand we have ever seen, the last tailing in their long line of screens, and asked us if we could suggest any commercial use for it. We turned it over to a chemical friend and he reported back that the best he could suggest was to use it in spinach.

* * *

Cheap Street Cleaning

There's a taxi rate war on in New York City and you can ride now for 20 cents a mile. This is a suggestion by Frueh in the New York *World*.

* * *

Sir—Yesterday I saw the following on the bulletin board in the lobby of Central Y. M. C. A., Chicago:

"The Y. M. C. A. is engaged in one of the most delicate tasks in spiritual engineering—building bridges which will join the hearts of different races."

W. M. O.

* * *

Finance and Rainfall

Wall Street has been blamed for almost everything that goes wrong in this country, but Mayor Hylan, of New York, who has been visiting in California, comes out with a new one. "The interests" are responsible for the Pacific Coast drought. Says the Mayor:

* * *

"The country west of the Rockies, particularly the Pacific slope, is very dry and sorely in need of water. If the federal authorities at Washington could get their powerful bosses, the international bankers in Wall Street, and let them collect some of the billions loaned to foreign governments and spend a little of this money to help conserve water for irrigation and other necessary purposes in the West they would be doing something for the people of the United States. However, such a policy would not benefit the financial interests."

Engineering Societies

Calendar

Annual Meetings

AMERICAN SOCIETY OF SANITARY ENGINEERING, New York; Annual Convention, Philadelphia, Pa., Sept. 9-12, 1924.

NEW ENGLAND WATER WORKS ASSOCIATION, Boston, Mass.; Annual Meeting, Rochester, N. Y.; Sept. 30 to Oct. 3.

AMERICAN SOCIETY FOR MUNICIPAL IMPROVEMENTS, St. Petersburgh, Fla.: Annual Convention, Boston, Mass., Sept. 29-Oct. 3, 1924.

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York; Fall Meeting, Detroit, Oct. 23-25, 1924.

The Fort Worth and Dallas, Texas, Chapters of the American Association of Engineers held a joint meeting July 12. Reports were made by the joint delegates from the recent national convention. Talks were also made by J. C. Nagle and R. A. Thompson, engineers in charge of the new $500,000 water reservoir for Dallas. M. J. McCombs, engineer in charge of surveys for Dallas, reported on the proposed engineers' licensing law for Texas.

Personal Notes

E. E. McADAMS, city manager of Bryan, Texas, has resigned to become city manager of Waco, Texas.

CHARLES S. WIDDOWS, Stockton, Calif., has been named chief engineer of the Woodbridge Irrigation District, recently organized in San Joaquin County, California.

HAROLD C. CLOUDMAN, engineer of Berkeley, Calif., has announced his candidacy for assemblyman. Mr. Cloudman for the past five years was with the U. S. Geological Survey as chief of the field division in the classification of lands in the Water Resources Branch. During the World War he served as captain of engineers.

F. T. CROWE, construction engineer, on the Tieton dam of the Bureau of Reclamation project at Rimrock, Wash., has been made general superintendent of construction, superseding JAMES MUNN who resigned to join the staff of A. P. Davis, consulting engineer for the East Bay Municipal Water District at Oakland, Calif. WALTER WARD, construction engineer for the Black Canyon dam on the Boise Project, has been transferred to the Tieton dam.

LEEDS & BARNARD, consulting engineers of Los Angeles, Calif., have made an affiliation with Dr. J. A. L. Waddell whereby the firm will undertake the design and supervision of construction of bridges in southern California, Utah, Nevada, Arizona and New Mexico. Under this arrangement economic studies, estimates of cost, plans and specifications will be prepared by Dr. Waddell while the Los Angeles firm will inspect and supervise construction for the owner.

THOMAS L. BRANSFORD, a Vanderbilt University student from Union City, Tenn., has been appointed assistant city engineer at Jackson, Tenn., and will serve in the interim before he returns to college.

DANA E. KEPNER, formerly assistant engineer with the Sanitary District of Chicago, has been appointed sanitary engineer for the Colorado State Board of Health, with headquarters in the state office building at Denver. Colorado is now the thirty-ninth state to have a sanitary engineering division of its health board.

COL. HARRY BURGESS, Corps of Engineers, stationed at Fort Sam Houston, Tex., has been assigned to duty as commandant of the engineering station and school at Fort Humphreys, Va., to take effect September 1. He will relieve COL. JAMES A. WOODRUFF, Corps of Engineers, scheduled for other duty.

THOMAS J. McCLURE, assistant city engineer of Tulare, Calif., has been relieved of his position, effective Aug. 1. The position was declared vacated by City Manager W. J. Andrews who declared it necessary due due to a deficit in city funds.

DWIGHT L. HOOPINGARNER has been elected director of the New York Building Congress, being the first to serve in that capacity. Mr. Hoopingarner will continue his service as the executive of the American Construction Council, inasmuch as the work is along national lines closely allied with the work of the New York Building Congress. His work with the construction industry has included the administration of associations handling general economic, labor and public relations for the building industry in important centers of the country. Mr. Hoopingarner was at one time director of employment and education at the National Bank of Commerce, New York City. Formerly, as a member of the faculty of the Harvard Business School, he organized the first group of labor courses given there.

WILLIAM G. TAYLOR has been appointed sanitary engineer of Paterson, N. J.; his duties will consist of making studies of the city's sewer system and advising on sanitary matters. He has been deputy chief engineer of the Passaic Valley Sewerage Commission and will give some time in an advisory capacity to that work.

LESTER CANADY, an assistant engineer on the Gordon Valley water project for the city of Vallejo, Calif., has been appointed project engineer by the city council.

COL. FRANCIS W. W. DOANE, city engineer of Halifax, Nova Scotia, has resigned after thirty-three years of service. On his retirement, officials of the city presented him with an address and a watch. Colonel Doane was one of the early members of the old Canadian Society of Civil Engineers, is a past-president of the Nova Scotia Institute of Science and was one of the founders of the Union of Nova Scotia Municipalities. While serving the city of Halifax, he has also acted in a consulting capacity for other cities in Canada and the United States, and to this work he will now confine himself.

C. C. REYNOLDS, formerly associated with Smith, Reynolds & Brandt, architects and engineers, Manitowoc, Wis., has severed his connection with that firm and has opened an office in Manitowoc for architectural and engineering practice.

Obituary

DANIEL F. BONTECOU, formerly prominent as a civil engineer in Kansas City, Mo., died July 14 at his home in Mamaroneck, N. Y., at the age of 73 years. Mr. Bontecou was born in Springfield, Mass., and graduated in 1871 from the College of the City of New York. He served as assistant engineer for the New York Central R.R., for the New York State Barge Canal, and in the Department of Public Works in New York City. Going to Kansas City in 1881, he formed a partnership with William B. Knight, known as Knight & Bontecou, civil engineers, but from 1891 he practiced alone. He was for a time chief engineer of the Kansas City Belt Railway Co. After serving on construction of the cable railway system of the Capitol Traction Co. in Washington, D. C., he became chief engineer of the Kansas City, Fort Scott & Memphis R.R. Mr. Bontecou was a former director and a former vice-president of the American Society of Civil Engineers and was a member of its committee on development in 1919.

CHARLES A. FERRY, consulting engineer, New Haven, Conn., died Aug. 1 of heart disease at his home in that city, aged 73 years. Mr. Ferry was born in Granby, Mass., graduated from Sheffield Scientific School in 1871 and received his C.E. degree from Yale University in 1891. For some time he was assistant city engineer of New Haven in charge of sewer work and masonry construction. As consulting engineer, his special assignments have been on water-works, sewers and determination of property lines. His most noted work was the designing and supervision of construction of the Yale University bowl. He was a former president of the Connecticut Society of Civil Engineers.

ALBERT J. FRANCIS, contractor and builder, St. Louis, Mo., died there July 30 in St. John's Hospital after an illness of several weeks; he was 53 years of age.

W. J. McCOURT, at one time superintendent of the Chicago water department for fifteen years, died July 31. He was a strong advocate of waste prevention by metering, but was handicapped by lack of appropriations by the city council for the installation even of meters called for by existing ordinances.

From the Manufacturer's Point of View

A Point of Contact Between Maker and User of Construction Equipment and Materials

Date Announced for 1925 Good Roads Show

Chicago Coliseum Will House Big Equipment and Materials Exhibit Jan. 5-9

THE 1925 Road Show and Convention of the American Road Builders' Association will be held at Chicago Jan. 5 to 9, inclusive. C. M. Upham, business director of the association, announces that better arrangements have been made for both the show and convention than in previous years. The preliminary plans also are already as far along as has been usual at a much later date. The show will be staged in the Coliseum and the convention sessions will be held in the Congress Hotel.

The program committee which will have charge of the convention will be headed by Prof. T. R. Agg. He expects to have the organization of his committee completed soon.

Space Added to Coliseum

Nearly 17,000 sq. ft. of additional floor space suitable for heavy exhibits will be provided at the Coliseum. This additional space is being obtained by the extension of the Coliseum to the north. The present main building and the adjoining building which have been used in the past also will be available. There will thus be room for more and better exhibits than in the past.

Additional doors for bringing in the heavy exhibits also have been arranged. Plenty of time to get the exhibits into the buildings will be allowed by the schedules made possible by the dates of the show.

Application blanks for space in the Road Show will be mailed shortly by Mr. Upham to all concerns whose names are available. Additional blanks may be obtained by addressing him at 37 West 39th Street, New York City.

Committees are being formed to handle the annual banquet, hotel arrangements, registration and various other features. The plans for these features, as well as for the show and convention, will all be completed much earlier than has been the case in previous years. With greater interest in highway building than ever before, the attendance from all parts of the country, it is predicted, will break the remarkable records of last year's show and convention.

Steel Sash Manufacturers Plan Organization with A.G.C.

Washington Correspondence

Manufacturers of steel sash and casement windows met in Chicago July 21 with Col. D. H. Sawyer, secretary of the Associated General Contractors of America, for a discussion of problems mutual to the producers and the contractors. The subject of forming an affiliated bureau of the Associated General Contractors was considered in detail.

The metal sash and casement windows manufacturers present, forming one of seven groups of producers of metal products used in the construction industry named to consider association with the A.G.C., deferred definite action until September, when another conference will be held in Washington and at which time it is expected that the manufacturers will form a trade association and give further consideration to affiliation with the general contractors' organization as a co-operating bureau. Guy Bayley, of the Bayley Manufacturing Co., presided at the Chicago meeting.

One of the subjects discussed by the sash and window manufacturers was the desirability of a standard form of contract for use between them and building contractors, to cover payments, deliveries and essential points.

Business Notes

SIX WHEEL CO., Philadelphia, is the name of a new company, headed by Charles M. Schwab of the Bethlehem Steel Corporation, which will manufacture motor trucks and buses equipped with six wheels. The four rear wheels of the machines will be assembled as a unit similar to the trucks of a railway car. Power and brakes will be applied to all four rear wheels.

CHAIN BELT CO., Milwaukee, elected the following officers at its annual meeting recently held in Milwaukee: J. C. Merwin, second vice-president; Brinton Welser, secretary; and C. E. Stone, assistant secretary. Re-elected officers are: C. R. Messinger, president; Clifford F. Messinger, first vice-president; and C. L. Pfeifer, treasurer.

AMERICAN ROLLING MILL CO., Middletown, Ohio, has established a district office at 1408 B. F. Keith Bldg., Cleveland. H. M. Richards, recently of the Pittsburgh district office, will be in charge, assisted by J. T. Hagan of Cleveland.

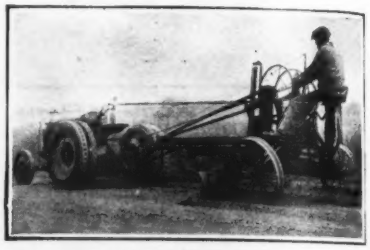
R. L. MEAD, formerly engineer and salesman with the Brown Hoisting Machinery Co., Cleveland, has been made western sales manager for the Ohio Locomotive Crane Co., with offices in the Railway Exchange Building, Chicago.

C. K. WEHN has been made assistant sales manager of the standard building department, Blaw-Knox Co., Pittsburgh. He will also retain his present position with the company in charge of sales of steel buildings in the Pittsburgh district.

Equipment and Materials

Road Grader Designed for Attachment to Fordson Tractor

A road grader with 7-ft. blade designed for attachment to a Fordson tractor is the most recent addition to the line of leaning-wheel road graders manufactured by J. D. Adams & Co., Indianapolis. The grader is a two-wheeled machine, from the seat of which the tractor may be controlled by a hand wheel and steering shaft with universal joints and by lever-operated cables. The wheelbase, or distance between the grader axle and the rear



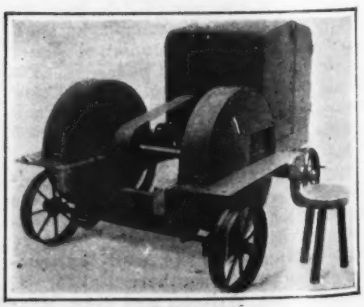
wheel of the tractor, is 13 ft. The grader frame is shiftable on the rear axle a distance of 22 in. With all necessary connections for the tractor the grader weighs 1750 lb. Blade extensions 1½ ft. long for each end may be furnished.

In operating the tractor from the grader man's seat, there are three controls; gear shift, clutch and steering. A foot pedal on the grader platform controls the clutch. The gear shift is operated by a shaft held by the right hand of the man in the accompanying illustration. The steering wheel is taken off the steering column of the tractor and a special device installed consisting of a couple of closely fitted knuckles which form a universal joint. The entire outfit can be turned around in a width of 21 ft. The grader can be connected to or disconnected from the tractor, the manufacturer states, in less than half an hour.

Machine Cleans Mortar from Used Brick

For cleaning and salvaging brick from house wrecking operations the Lyon Iron Works, Greene, N. Y., is marketing a machine with two cutter heads mounted on a shaft driven by

(*Continued on p. 242*)



Contractor's Plant Expense Analyzed by A. G. C.

Detailed Schedule Prepared Showing Economical Life and Cost in Per Cent of Capital Investment

BASED on a four years' investigation, a report has just been completed by the Associated General Contractors of America, Washington, D. C., dealing with the problems of construction equipment ownership and maintenance. Of particular interest is an analysis of equipment expense expressed as a percentage of the original capital investment, as set forth in detail in the accompanying table.

In explanation of the figures in the table the Associated General Contractors points out that equipment expense, as treated in the report, covers only ownership and maintenance, and does not include the cost of loading, shipping, erecting, operating or dismantling for any particular construction project.

In the table all net percentages shown are based upon actual costs, and represent no element of profit. The items include no allowances for fuel, lubricants, supplies, transportation or crew wages, no portion of the owner's general expense of doing business, and no allowance for risk of less than the average amount of annual equipment employment.

Caution is necessary, the report states, in arbitrarily using percentages such as those given in the schedule. There may be some danger in applying these percentages to particular cases, unless the conditions under which the equipment is to work are carefully investigated.

To illustrate: If the values given in the schedule for a standard gage railway steam shovel outfit were applied to an outfit in the North engaged constantly in excavating hard rock, the probability is that the charges would not cover the expense. Frequent dobey shots and the dropping of heavy boulders of frozen material into cars entail a higher rate of depreciation and repairs than is given in the schedule. On the other hand, if this shovel outfit were steadily engaged in the South, or along the Pacific Coast, in digging sandy loam, the values given in the table would probably cause the equipment charge to contain an element of profit. Such a schedule as that given, it is explained, merely sums up the experience of typical contracting firms, and its value to others depends upon the individual judgment used in interpreting it in the light of circumstances surrounding a particular job, and applying to it the local "experience rating" developed through recent successive years.

Welding and Cutting—The Oxweld Acetylene Co., Long Island City, N. Y., has just published a 48-p. catalog illustrating and describing in detail its line of acetylene generators and oxy-acetylene welding, cutting, brazing, lead burning, heating and decarbonizing equipment. The book contains information useful to the user or prospective user of oxy-acetylene welding and cutting apparatus.

Construction Equipment Schedule

The table of percentage values given below represents for individual construction machines the annual expense of equipment ownership and maintenance, expressed in terms of original capital investment.

Equipment (1)	—Annual Expense, Per Cent of Capital Investment— Economical Life, Years (2)	Depreciation (3)	Interest (4)	Major or Shop Repairs (5)	Minor or Field Repairs (6)	Storage Incidentals, Equip., Overh'd (7)	Insurance (8)	Taxes (9)	Total (10)	Average Use Months, per Year (11)	Expense Per Working Month, Per Cent (12)
Auto-crane, gas	5	30	5	8	6	4	1	1	45	8	5.6
Auto-crane, steam	6	27	5	8	5	4	1	1	41	8	5.1
Auto-truck	3	33	5	16	16	4	1	1	76	10	7.6
Auto-trailer	5	20	5	6	6	4	1	1	43	9	4.7
Backfiller, power	4	25	5	6	6	4	1	1	48	6	8.0
Ballast spreader	8	13	5	6	4	4	1	1	34	6	5.6
Boiler, upright	8	13	5	20	5	4	1	1	49	6	8.1
Boiler, locomotive	8	13	5	15	5	4	1	1	46	6	7.6
Bucket, clamshell	4	25	5	15	6	4	1	1	57	8	7.1
Bucket, orange-peel	4	25	5	25	6	4	1	1	67	7	9.6
Bucket, drag-line	4	25	5	12	4	4	1	1	52	6	8.6
Cars, steel dump	6	17	5	8	4	4		1	40	7	5.7
Cars, wood dump	5	20	5	10	5	4	1	1	46	7	6.5
Cars, flat	8	13	5	6	4	4	1	1	34	7	4.8
Cars, hopper	5	20	5	10	4	4	1	1	45	7	6.4
Compressor, steam	7	14	5	6	4	4	1	1	35	7	5.0
Compressor, gasoline	6	17	5	6	8	4	1	1	42	7	6.0
Compressor, electric	7	14	5	5	4	4	1	1	34	7	4.8
Concrete chutes	2	50	5	10	15	4	1	1	86	9	9.6
Conveyor, belt	2	50	5	6	10	4	1	1	77	8	9.6
Conveyor bucket, portable	3	33	5	10	6	4	1	1	60	7	8.5
Crusher, rock, portable	5	20	5	10	4	4	1	1	45	6	7.5
Derrick, wood	5	20	5	4	4	4	1	1	39	6	6.5
Derrick, steel	8	13	5	4	3	4	1	1	31	6	5.1
Drag-line, steam	6	17	5	8	8	4	1	1	44	8	5.5
Drag-line, gasoline	5	20	5	8	10	4	1	1	49	8	6.1
Drag-line, electric	6	17	5	8	8	4	1	1	44	8	5.5
Drill, tunnel, carriage	5	20	5	8	8	4	1	1	47	8	5.8
Drill, traction well	6	17	5	7	10	4	1	1	45	8	5.6
Drill, tripod	4	25	5	7	10	4	1	1	43	9	4.7
Drill, jack hammer	2	50	5	5	15	4	1	1	81	9	9.0
Engine, gas	5	20	5	7	10	4	1	1	48	8	6.0
Engine, steam without boiler	10	10	5	5	5	4	1	1	31	8	3.8
Excavator, cableway complete	5	20	5	4	12	4	1	1	47	9	5.2
Excavator, trench, steam	6	17	5	8	4	4	1	1	40	9	4.4
Excavator, trench, gas	5	20	5	8	10	4	1	1	49	9	5.4
Forms, steel concrete	2	50	5	5	10	4	1	1	76	8	9.5
Graders, common road	4	25	5	12	6	4	1	1	54	10	5.4
Graders, elevating	4	25	5	15	9	4	1	1	60	10	6.0
Hoist, steam	8	13	5	6	4	4	1	1	34	9	3.7
Hoist, gasoline	6	17	5	7	8	4	1	1	43	9	4.7
Hoist, electric	8	13	5	6	4	4	1	1	34	9	3.7
Locomotive, industrial steam	8	13	5	8	6	4	1	1	38	9	4.2
Locomotive, industrial gas	5	20	5	10	10	4	1	1	51	9	5.6
Locomotive, industrial battery	4	25	5	8	12	4	1	1	56	9	6.2
Locomotive, standard gage	10	10	5	8	6	4	1	1	35	10	3.5
Locomotive crane, steam	8	13	5	8	4	4	1	1	36	10	3.6
Locomotive crane, gas	7	14	5	8	8	4	1	1	41	10	4.1
Mixer, steam	5	20	5	10	6	4	1	1	47	8	5.8
Mixer, gasoline	4	25	5	10	10	4	1	1	56	8	7.0
Mixer, electric	5	20	5	10	6	4	1	1	47	8	5.8
Mixer, paving, steam	5	20	5	12	6	4	1	1	49	6	8.1
Mixer, paving, gas	4	25	5	12	10	4	1	1	58	6	9.6
Motors	6	17	5	6	4	4	1	1	38	8	4.7
Pile driver, steam	8	13	5	8	6	4	1	1	38	6	6.3
Pile driver, track	10	10	5	8	4	4	1	1	33	6	5.5
Pile hammer, steam	5	17	5	10	5	4	1	1	43	6	7.1
Pipe, galvanized	3	33	5	10	10	4	1	1	54	8	6.7
Plows	3	33	5	15	10	4	1	1	69	10	6.9
Pneumatic concrete machine	4	25	5	20	8	4	1	1	64	7	9.1
Pump, centrifugal	5	20	5	6	4	4	1	1	41	6	6.8
Pump, piston	5	20	5	7	5	4	1	1	43	6	7.1
Pump, impulse	8	13	5	2	4	4	1	1	30	6	5.0
Rails	5	20	5	0	5	4	1	1	36	9	4.0
Riveter, air	2	50	5	10	10	4	1	1	81	10	8.1
Rock channeler	6	17	5	8	8	4	1	1	44	6	7.3
Roller, steam road	8	13	5	6	6	4	1	1	36	7	5.1
Roller, gas road	7	14	5	8	10	4	1	1	43	7	6.1
Saw rigs	4	25	5	10	15	4	1	1	61	8	7.6
Scraper, wheel	3	33	5	8	4	4	1	1	56	9	6.2
Scraper, slip	2	50	5	25	10	4	1	1	96	10	9.6
Scraper, fresno	3	33	5	25	15	4	1	1	84	9	9.3
Shovel, steam	6	17	5	8	6	4	1	1	42	10	4.2
Shovel, gasoline	5	20	5	10	10	4	1	1	51	10	5.1
Shovel, electric	6	17	5	8	6	4	1	1	42	10	4.2
Switches, fabricated	3	33	5	5	5	4	1	1	54	9	6.0
Tower, steel hoist	7	14	5	5	5	4	1	1	35	8	4.3
Tractor, steam	6	17	5	8	6	4	1	1	42	10	4.2
Tractor, gas	5	20	5	8	10	4	1	1	49	10	4.9
Wagons, dump	4	25	5	14	6	4	1	1	56	10	5.6
Wagons, hauling	4	25	5	12	4	4	1	1	52	10	5.2
Wagon loaders, power, bucket or belt	5	20	5	10	6	4	1	1	47	9	5.2

(A supplementary schedule for marine equipment will be published next week.)

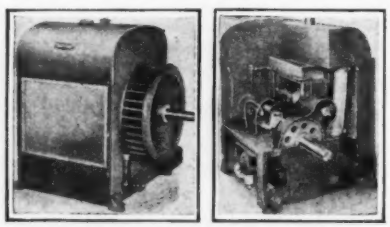
a 2-hp. gasoline engine. The brick are cleaned by being pressed against the sides of the rapidly revolving cutter heads which quickly remove the mortar and give the sides of the brick a true flat surface.

Each cutter head has 24 radial rods on which rotate several hundred star-shaped cutters and round washers of the same size. These cutters are staggered in the head so that the whole face of the brick is cleaned. The cutter head revolves about 500 r.p.m. The rolling principle of the cutters, the manufacturer points out, prevents a sharp impact upon the brick, thus, minimizing breakage of the brick. The head is so designed that the cutters may be easily replaced after they become worn.

The machine is mounted on a portable truck so that it can be backed up to the pile of brick. Low seats are provided for the operator to save time in securing brick from the pile. An engine housing protects the machine in stormy weather and the cutter heads are covered with guards which also serve to collect the dust, which is blown out of a chute at the rear.

Small Power Unit Has Inverted Cylinders

A departure from the automobile type of gasoline engine for construction and industrial use is found in the 5-10 hp. two-cylinder power unit called the Denison Powermaker, built by the



Cook Motor Co., Delaware, Ohio. Inverted cylinder construction is one of the features of the design, resulting in the location of the crankshaft above instead of below the cylinders, the gravitation of the fuel to the carburetor and explosion chamber, and the elimination of crank case oil dilution.

The unit weighs 550 lb., has base dimensions of 24¾ x 25¾ in. and overall height of 33 in. It is equipped with two power take off shafts—one the crankshaft proper running at speeds from 500 to 1,200 r.p.m. and the other a gear reduction shaft operating at 250 to 600 r.p.m.

The engine, equipped with radiator, is water-cooled by the thermo-syphon, system, eliminating the use of a circulating pump. Rigidity and proper alignment are secured by the inclusion of the cylinders, bearing standards and base in a single casting.

With the inverted cylinder design the crankshaft, cam shaft, magneto, governor assembly and connecting rods are located on top of the main base casting, readily accessible for adjustment or repair. The power unit is inclosed in a pressed steel housing of No. 16 gage metal. Lubrication is by the mechanical force feed system.

Business Side of Construction

FACTS AND EVENTS THAT AFFECT COST AND VOLUME

Business Briefs

Call money remains at 2 per cent, Aug. 4.

Time loans, short terms, 2½@2¾ per cent; longer periods, 3@3¾ per cent.

Commercial paper, best names, 3½@3¾ per cent; other names, 3¾ per cent.

Foreign exchange (Demand):

	Normal	This Week	Last Week	Year Ago
Sterling	$4.8665	$4.45¾	$4.39½	$4.56½
Franc	0.193	0.0539½	0.0508	0.0577½
Lira	0.193	0.0439½	0.0436	0.0434

Bids Wanted on Big Jobs

Among the projects on which bids are either asked or will soon be called for in Construction News, pp. 71 to 86, are the following:

Hospital, Morris Plains, N. J., A. B. Mills, $1,500,000.

Bank and Office, Philadelphia, Pa., by Dennison and Hirons, $1,250,000.

Unit Prices Bid on Road Materials in Place

Unit prices bid on materials in place on highway contracts awarded during the past month in five representative states, are given in the accompanying table.

These figures are from the report of the Bureau of Public Roads, U. S. Department of Agriculture and cover earth, gravel, brick and reinforced concrete road construction.

The wage rates for common labor for this class of work range between 35c. and 50c. per hr. in the five states.

Foreign Projects of Interest to Americans

A number of foreign construction projects which should be of interest to American engineers, contractors and manufacturers have been reported by the United States Department of Commerce. They are noted here, further information being available at the Bureau of Foreign and Domestic Commerce or its district co-operative offices when a reference number is given.

Highway construction planned in Pernambuco which will involve a distance of about 120 miles. Reference No. 136,963.

Dock to be built in Venezuela. An oil company has been granted permission to construct docks and pier facilities near Caracas. Reference No. 136,892.

New Railroad to be built in Pernambuco. A railroad of about 18 miles in length will be constructed in the southern coastal belt of Pernamburo. Reference No. 136,930.

Warehouses for a railroad to be built in Cuba. Expenditure will approximate $7,000,000. Reference No. Cuba 35X.

Sewer construction for Kingston, Jamaica has been taken over by the city government. It is stated that the work will involve an expenditure of about £50,000 sterling.

Port improvements have been authorized by the Chilean government. Information and specifications at the Chilean Consulate in New York City.

BID PRICES ON ROAD MATERIALS IN PLACE

County	Contract Let to	Gross Bid	Length, Miles	Type	Width of Surfacing, Ft.	Thickness of Surfacing, In.	Unit Prices Bid—Materials in Place: Surfacing Sq.Yds.	Surfacing Unit Price	Excavation Cu.Yds.	Excavation Unit Price	Rock Excavation Cu.Yds.	Rock Excavation Unit Price	Structural 1-2-4 Cu.Yds.	Structural 1-2-4 Unit Price	Concrete 1-3-6 Cu.Yds.	Concrete 1-3-6 Unit Price	Steel Reinforcing Lbs.	Steel Reinforcing Unit Price
IOWA																		
Howard Co.	Shirley Const. Co.	$21,075	5.025	Earth	28	...	.....	.....	57,676	$0.29½	.....	.....	.....	.....	...	.....	.....	.....
MONTANA							Cu.Yd.											
Valley Co.	Fitzgerald & Staunton	95,115	15.79	Crushed (Gravel)	15	7½	25,581	$1.70	132,287	.25	797	$1.00	247	$20.00	...	.....	13,872	$0.09
Dawson Co.	Boomer, McGuire, & Blakeslee	273,939	.....	Bridge	..	...	.....	.....	.....	.....	...	.....	2,025	17.50	...	.....	207,000 ‡1,800,000	.055 .07
OHIO							Sq.Yd.											
Wayne Co.	The Holmes Const. Co.	85,234	2.063	Brick	18	10	19,351	3.72	.....	.....	...	.....	74	20.00	12	$14.00	14,197	.07
PENNSYLVANIA																		
Schuylkill Co.	W. H. Murphy & Sons	405,903	24.468	Reinf. Conc.*	18	6	41,493	3.50	.....	.....	...	.....	92	30.00	203	20.00	10,564	.10
VERMONT																		
Chittenden Co.	Earl & Merry	112,678	2.955	Concrete†	18	6	22,781 2,522	2.92 3.34	13,280	1.25	55	5.00	368	20.00	...	.....	111,491	.06

* Mix 1-2-3. † Mix 1-2-4. ‡ Structural.

July Construction Ahead of Preceding Month and Corresponding Period in 1923

Decided Gains Made in the New England, Middle Atlantic, Southern and Middle Western Sections

Contracts awarded on large engineering construction projects, as published in the five issues of *Engineering News-Record* during July, totaled $202,095,000 as compared with $155,140,000 in the four issues of June, 1924. Awards published in the four issues of July, 1923, amounted to $163,459,000.

The average weekly value of July lettings was $40,819,000 as against $38,785,000 for June.

Minimum costs observed in the Construction News section of *Engineering News-Record* on each class of construction are as follows: Waterworks and excavations, $15,000; other public works, $25,000; industrial construction, $40,000 and commercial buildings, $150,000.

The money value of contracts awarded during July was greater than that for the month preceding in the following sections: New England, Middle Atlantic, Southern and Middle West. The New England total is the largest for that section since January. The July awards for the Middle Atlantic and the Southern sections are the largest for these sections so far this year. The total for May for the Middle West is the largest for that section for the present year.

The increase in the total money value of awards for July seems to be a reflection of the general condition throughout the country.

Among the large projects awarded during July were the following: training school, New York City, $1,735,000; railway shops, Hayne, S. C., $3,000,000; bridge, Jersey City, N. J., $1,342,783; office, Chicago, Ill., $5,000,000; steam turbine station, Kingston, Pa., $5,000,000; theater and office, Chicago, $2,000,000; municipal building, Brooklyn, $4,397,140; printing plant, Chicago, $2,000,000; subway, Philadelphia, $14,215,100; bridge approaches, Philadelphia, $3,305,500; factory, Troy, N. Y., $3,500,000; roundhouse, Binghamton, N. Y., $2,250,000.

Large Contracts Let During Week

Among the week's announcements of contracts awarded in Construction News, pp. 71 to 86, are the following:

Bridge, Portland, Ore., to Pacific Bridge Co., $2,370,473.

Club, Los Angeles, Calif., to Lange and Bergstrom, $2,200,000.

Bank and Office, Youngstown, O., to Mellon-Stuart Co., $1,500,000 to $2,000,000.

Office, Chicago, Ill., to Bulley and Andrews, $1,000,000.

Apartment Hotel, Providence, R. I., to Shape, Bready and Peterkin, New York City, $1,300,000.

Apartment Hotel, St. Paul, Minn., to H. C. Struchen, $1,000,000.

Engineering News-Record Construction Cost Index Number

August, 1924	213.15
July, 1924	214.40
August, 1923	221.50
Peak, June, 1920	273.80
1913	100.00

Jan., 1923	191.70	Sept.	221.50
Feb.	197.40	Oct.	220.30
Mar.	205.25	Nov.	220.90
Apr.	213.50	Dec.	217.30
May	216.70	Jan., 1924	217.90
June	220.70	Feb.	220.30
July	222.10	Mar.	224.70
Aug.	221.50	Apr.	221.60
		May	222.38

Engineering News-Record's Construction Cost Index Number declined 1.25 points since last month, owing to lower steel and lumber prices. The average rate for common labor is still 56c. per hr., against 55c. four months ago and 54c. in July, 1923. Thus general construction cost is 4 per cent lower than one year ago and 22 per cent under the peak; it is 113 per cent above the 1913 level.

Engineering News-Record Construction Volume Index Number

Monthly

July, 1924 *(5 issues of E. N.-R.)*	165
June, 1924 *(4 issues of E. N.-R.)*	126
July, 1923 *(4 issues of E. N.-R.)*	128

Yearly

1923 (entire year)	135
1922 (entire yaer)	130
1921 (entire year)	88
1920 (entire year)	91
1919 (entire year)	91
1918 (entire year)	80
1917 (entire year)	64
1913 (entire year)	100

Engineering News-Record's Construction Volume Index Number is 165 for the month of July, and 135 for the whole of 1923, as against 100 for 1913. This means that the actual volume of construction in 1923 (not the mere money-value of the contracts let that year) is 35 per cent above the volume of construction for 1913. Our monthly volume number, 165 for July, 1924, contains the increment of construction, and indicates the rate at which contracts are being let as compared with 1913 awards.

VALUE OF CONTRACTS LET IN THE UNITED STATES AND CANADA DURING JULY, 1924

	New England	Middle Atlantic	Southern	Middle West	West of Mississippi	West	Total United States	Canada	Grand Total
Waterworks	$471,000	$456,000	$2,662,000	$709,000	$375,000	$174,000	$4,847,000	$120,000	$4,967,000
Sewers	206,000	2,769,000	236,000	2,262,000	596,000	144,000	6,213,000	194,000	6,407,000
Bridges	1,059,000	5,468,000	1,217,000	1,224,000	1,592,000	1,002,000	11,562,000	38,000	11,600,000
Excavation, drainage, etc.	.....	172,000	257,000	.....	1,555,000	65,000	2,049,000	.....	2,049,000
Streets and roads	2,605,000	11,831,000	8,285,000	10,365,000	8,884,000	2,675,000	44,645,000	1,139,000	45,784,000
Industrial works	1,010,000	12,631,000	3,300,000	5,287,000	1,033,000	760,000	24,021,000	1,200,000	25,221,000
Commercial Buildings	9,659,000	19,155,000	6,953,000	26,305,000	7,925,000	6,018,000	76,015,000	.....	76,015,000
Federal government	12,000	2,657,000	1,494,000	187,000	117,000	1,022,000	5,489,000	.....	5,489,000
Unclassified	274,000	15,507,000	3,407,000	4,508,000	670,000	72,000	24,438,000	125,000	24,563,000
Total	$15,296,000	$70,646,000	$27,811,000	$50,847,000	$22,747,000	$11,932,000	$199,279,000	$2,816,000	$202,095,000

Labor Rates and Conditions Throughout the Country

That conditions throughout the country are good and that a general improvement is in evidence may be seen by the following: (1) demand is now gaining in some lines on the current rates of production; (2) wages are high in relation to the cost of living which is the reverse of 1920 and 1921, when conditions were unfavorable; (3) prices are holding, in some cases going up; (4) unemployment is not increasing; (5) lumber orders continue to gain, the demand being heavier than in 1923; (6) car loadings on the increase, especially grain, grain products, and merchandise; (7) construction industry in a strong position; (8) shipments and production of cement heavy; (9) agricultural conditions better than expected, with price advance in corn and wheat, and a good fruit crop.

Wages throughout the country are still high with very few reductions reported. This leaves the average rate paid common laborers (pick and shovel men) in construction operations 56c. per hr. for the entire country. This rate has prevailed for the past three months.

Local conditions as reported to *Engineering News-Record* follow:

Atlanta—Plenty of building materails on hand. Construction fairly active.

Baltimore—Conditions normal in the skilled building trades.

CURRENT BUILDING TRADES WAGE RATES PER HOUR

(Higher rates indicated by +, decreases by —)

Cities	Brick-layers	Car-penters	Hoisting Engineers	Hod Carriers	Pile Drivers	Structural Iron Workers	Common Labor
Atlanta	$1.12½	$0.70	$0.70	$0.50	.....	$0.75	$0.25@.30
Baltimore	1.75	.90@1.20	1.00@1.12½	1.00	$0.65	1.12½	.40
Birmingham	+1.00@1.50	—.25@.75	.75@1.00	+.35@.45	.....	1.00	.25@.40
Boston	1.25	1.00@1.10	1.25@1.35	.82½	1.05	1.12½	.60@.75
Cincinnati	1.50	1.20	1.20	.92½	1.20	1.20	.55
Chicago	+1.50	1.15@1.25	1.00@1.25	.88¾	+1.25	1.25	.82½
Cleveland	1.50	1.25	1.25	.87½	1.00	1.37½	.87½
Dallas	1.50	1.00	1.00	.40@.75	.87½	1.00	.30@.50
Denver	1.62½	1.12½	1.12½@1.18¾	.81¼@.87½	1.00	1.15¾	.35@.55
Detroit	1.50	.90@1.00	.85@1.00	.90	.85@1.00	1.12½	.60@.75
Kansas City	1.37½	—1.00@1.12½	1.00@1.25	.90	1.00	—1.12	.40@.70
Los Angeles	1.25	1.00	1.00	+1.00	.....	—.87½	.50
Minneapolis	1.12½	.87½	.87½	.71½	.....	.87½	.50@.55
Montreal	1.00	.65	.62½	.45	.50	.65	.25@.30
New Orleans	1.25	.90	1.00	.65	.80	1.00	.35@.40
New York	1.50	1.31¼	1.50	1.00	1.00	1.31¼	.62½@.75
Philadelphia	1.50	1.12½	1.02½	+1.12½	1.00	1.12½	.40@.45
Pittsburgh	1.55	1.37½	+1.25	1.00	.....	1.37½	.70
St. Louis	1.75	1.50@1.60	1.50@1.67½	1.15@1.25	1.25	1.50	.45@1.10
San Francisco	1.25	1.00	1.00	.81¼	1.00	1.12½	.50@.55
Seattle	1.25	1.00	1.00@1.12½	.93¾	1.00@1.12½	1.12½	.62½

Birmingham — Surplus of common labor. Skilled workmen find conditions good. Prospects promising for increased activity in construction work.

Boston—A pronounced labor surplus in all trades.

Dallas—All skilled trades employed; small percentage of common labor idle.

Detroit — Construction activity slightly decreased. Plenty of men to supply all trades.

New Orleans—Laborers sufficient to meet all demands.

Philadelphia—Surplus of laborers for the various trades.

Pittsburgh — Trades well supplied with men.

San Francisco—Building trades actively employed.

Los Angeles—A steady demand for all kinds of building material continues. Plenty of work for contractors in buildings, streets and sewers. Less lumber was shipped into San Pedro during July than for any of the four previous months.

Kansas City—No shortage of labor in any of the building trades.

Montreal—No labor scarcity reported for any of the skilled trades.

New Orleans—Labor conditions unchanged. Labor sufficient to meet all demands.

St. Louis—Construction work suffered a decline in July. Four hundred and fifty union electricians went on strike August 1. No question of wages or working conditions is involved. An agreement could not be reached as to the time length of contract. The employers objected to an agreement that would expire on July 15, 1925, which would come in the busy season. It is feared that the walk-out will affect general construction.

New York—The following increases in wage rates per day agreed upon for 1924 have become effective for the following classes of labor: dock builders from $9 to $10.50; composition roofers and waterproofers, $9 to $9.50; derrickmen and riggers, $9 to $9.50; painters and decorators, $10 to $10.50; roofers and sheet metal workers, $10 to $10.50; tile layers, $10 to $10.50. The first figure in each case above shows the old rate.

Monthly Prices of Construction Materials

Ups and Downs of the Market

Current Rate of Demand Gaining in Some Lines on the Current Rate of Production

Pig Iron—No. 2 foundry iron is quoted at $18.00@$18.50, Birmingham. Little change is noted in the character of buying as consumers continue to keep in close connection with the mills. There has been a slight increase in production bringing the average for the country to about 45 per cent.

Steel Rails—There has been some buying of rails. Several inquiries have come in showing an increased interest. Little demand for freight car material at present although inquiries have been made concerning freight cars and locomotives.

Road and Paving Material—Advances have been made in road oil and asphalt in certain sections. July awards show an increase in road construction which makes for a greater demand.

Cement—Prices have changed very little throughout the country. Reserve stocks continue to increase.

Brick—Demand remains good but a drop in price is reported. New York City shows the greatest decline from $20 to $16@$17 per M. Production is on the increase.

Lumber—The reason for the decline in the western markets is that the demand has lessened, also the reserve stocks are very high due to the fact that the Japanese demand did not reach expectations. Boston and Minneapolis report drop in fir prices. Production is in advance of orders and shipments.

Hollow Tile—Denver reports that the advance in price is due to increased production costs.

Metal Lath—Prices in New York City advanced from $1 to $3 per 100 yd. depending upon the weight. The Standardization board advised the dropping of the odd weight—2.8 lb.

Explosives—Cincinnati and Birmingham report advances of ½c., 7c. per lb. respectively, while Kansas City shows a decline of 1½c. per lb.

White and Red Lead—A drop of ½c. per lb. is reported for both dry and in oil.

Scrap—Birmingham changes several quotations to a lower price. The market is very dull with very few sales.

Track Supplies — Chicago increased rates 65c. per lb. from last month's quotations. This is due to the recent orders placed by the Norfolk and Western Railway, while several other companies have entered the market for supplies. Louisville and Nashville Railway placed orders for 9,700 kegs of spikes and 1,650 pairs of angle bars.

Linseed Oil—Raw oil has advanced 5c. per gal in New York since July 3 on lots of 5 bbl. or more. This price was quoted, Aug. 2, 1924. Less than 5 bbl. lots is 3c. per gal. more than the quotation on the larger amount.

Price advances since last month are indicated by **heavy type**; declines by *italics*

PIG IRON—Per Gross Ton—Quotations compiled by The Matthew Addy Co.:

	Aug. 7	One Year Ago
CINCINNATI		
No. 2 Southern (silicon 2.25 @ 2.75)	**$22.05@22.55**	$25.50
Northern Basic	*20.00*	26.52
Southern Ohio No. 2 (silicon 1.75 @ 2.25)	*21.77*	26.52
NEW YORK, tidewater delivery		
Southern No. 2 (silicon 2.25 @ 2.75)	**28.05**	31.66
BIRMINGHAM		
No. 2 Foundry (silicon 2.25 @ 2.75)	*18@18.50*	20.50
PHILADELPHIA		
Eastern Pa., No. 2X (2.25@2.75 sil.)	*22.77@23.27*	28.32
Virginia No. 2 (silicon 2.25 @ 2.75)	**28.44@29.44**	29.74
Basic	*20@21*	26.00
Gray Forge	*21@22*	26.00
CHICAGO		
No. 2 Foundry Local (silicon 1.75 @ 2.25)	*20.00*	24.50
No. 2 Foundry Southern (silicon 2.25 @ 2.75)	**28.05**	27.17
PITTSBURGH, including freight charge from the Valley		
No. 2 Foundry Valley (silicon 1.75 @ 2.25)	*25.00*	25.50
Basic	*25.00*	25.50
Bessemer	**28.26**	25.50

SCRAP—The prices following are per gross ton paid to dealers and producers f.o.b. New York. In Chicago and St. Louis the quotations are per net ton and cover delivery at the buyer's works, including freight transfer charges.

	New York	Chicago	Birmingham
No. 1 railroad wrought	$14.00	$11.50	*10.00@11.00*
Stove plate	10.00	12.00	*14.00@15.00*
No. 1 machinery cast	14.00	16.50	*14.00*
Machine shop turnings	8.00	4.00	*6.00@7.00*
Cast borings	9.00	5.50	*8.00@9.00*
Railroad malleable	13.00	12.50	*13.00*
Re-rolling rails	14.00	13.00	*15.00@16.00*
Re-laying rails	22.00	30.00	*23.00*
Heavy melting steel	10.50	.....	.....

RAILWAY SUPPLIES

STEEL RAILS—The following quotations are per ton f.o.b. Pittsburgh and Chicago for carload or larger lots. For less than carload lots 5c. per 100 lb. is charged extra:

	Pittsburgh				
	Aug. 7	One Year Ago	Birmingham	Chicago	St. Louis
Standard bessemer rails	$43.00	$43.00	$43.00	$43.00	$46.00
Standard openhearth rails	43.00	43.00	43.00	43.00	46.00
Light rails, 8 to 10 lb.	38@40	45.00	2.00*	.....	2.55*
Light rails, 12 to 14 lb.	38@40	45.00	2.00*	.....	2.45*
Light rails, 25 to 45 lb.	38@40	45.00	2.00*	.....	2.35*
Rerolled Rails	35@36	39.00	.....	.....	2.10*

*Per 100 lb.

RAILWAY TIES—For fair-sized orders, the following prices per tie hold:

	6 In. x 8 In. by 8½ Ft.	7 In. x 9 In. by 8½ Ft.
Chicago, White Oak	*$1.45*	*$1.70*
Chicago, Hardwood and Red Oak	1.35@1.45	1.50@1.70
Chicago....Empty Cell Creosoting (add'l)	.50	.60
San Francisco..... Green Douglas Fir	.84	1.14
San Francisco, Empty Cell Creosoted. Douglas Fir	1.70	2.25
St. Louis, White Oak	1.25	1.45
St. Louis (creosoted) (sinc treated)	1.65	1.90
St. Louis, Red Oak, plain	1.15	1.35
St. Louis, Sap pine-cypress	1.00	1.20
Birmingham, white oak	*1.25*	*1.50*

TRACK SUPPLIES—The following prices are base per 100 lb. f.o.b. Pittsburgh for carload lots, together with the warehouse prices at the places named:

	Pittsburgh					
	Aug. 7	One Year Ago	Chicago	St. Louis	San Francisco	Birmingham
Standard spikes, ½-in. and larger	$2.90@3.00	$3.15	$3.65	$3.75	$4.85	$3.72
Track bolts	3.75@4.25	4.00@4.25	4.65	4.65	5.85	4.57
Standard section angle bars	2.75	2.75	3.40	*3.35*	4.00	3.20

PIPE

WROUGHT PIPE—The following mill discounts are to jobbers for carload lots on the latest Pittsburgh basing card:

BUTT WELD

Inches	Steel Black	Steel Galv.	Inches	Iron Black	Iron Galv.
1 to 3	62	50½	1 to 1½	30	13

LAP WELD

2	55	43½	2	23	7
2½ to 6	59	47½	2½	26	11
7 and 8	36	43½	3 to 6	28	13
9 and 10	54	41½	7 to 12	26	11
11 and 12	53	40½			

BUTT WELD, EXTRA STRONG, PLAIN ENDS

1 to 1½	60	49½	1 to 1½	30	14
2 to 3	61	50½			

LAP WELD, EXTRA STRONG, PLAIN ENDS

2	53	42½	2	23	9
2½ to 4	57	46½	2½ to 4	29	15
4½ to 6	56	45½	4½ to 6	28	14
7 and 8	52	39½	7 and 8	21	7
9 and 10	45	32½	9 to 12	16	2
11 and 12	44	31½			

WROUGHT PIPE—From warehouses at the places named the following discounts hold for steel pipe:

	Black			
	New York	Chicago	Birmingham	St. Louis
1 to 3 in. butt welded	48%	50%	61%	49%
2½ to 6 in. lap welded	44%	47%	58%	46%

	Galvanized			
	New York	Chicago	Birmingham	St. Louis
1 to 3 in. butt welded	34%	37%	50%	36%
2½ to 6 in. lap welded	30%	34%	48%	33%

Malleable fittings, Classes B and C, banded, from New York stock sell at list plus 4%, less 5%; class A, plus 23%. Cast iron, standard sizes, 34@5% off.

CAST-IRON PIPE—The following are prices per net ton for carload lots:

	Birmingham Mill	Pittsburgh	New York	
			Aug. 7	One Year Ago
4 in.	$53@54	$64.60@65.60	$65.60@66.60	$67.30
6 in. and over	50.00	59.60@60.60	60.60@61.60	62.30

	Chicago	St. Louis	San Francisco
4 in.	$61.20@62.20	$56.60	$63.00
6 in. and over	*56.20@57.20*	52.60	59.00

Gas pipe and Class "A," $5 per ton extra.

CLAY DRAIN TILE—The following prices are per 1000 lin.ft.:

	New York					
Size, In.	Aug. 7	One Year Ago	St. Louis	Chicago	San Francisco	Dallas
3	$45.00	$45.00	$50.00	*$50.00*	.....	$73.00
4	55.00	55.00	50.00	*60.00*	$76.50	83.00
5	80.00	80.00	.....	*90.00*	97.75	108.00
6	105.00	105.00	85.00	*100.00*	127.50	133.00
8	170.00	170.00	195.00	**200.00**	212.50	199.00

SEWER PIPE—The following prices are in cents per foot for standard pipe in car load lots, f.o.b., except as otherwise stated:

Size, In.	New York Delivered	Pittsburgh	Birmingham	St. Louis	Chicago	San Francisco	Dallas
3	.....	$0.093	$0.105	.....	**$0.17**	$0.12	.....
4	.....	.093	*.10*	$0.1175	**.17**	.15	$0.15
5	.....	.1395	**.14**	.....	**.26**	.18	.18
6	$0.24	.1395	.165	.1645	**.26**	.21	.21
8	.38	.217	**.265**	.26	**.41**	.30	.325
10	.57	.3255	**.385**	.364	**.61**	.42	.476
12	.72	.4185	**.46**	.468†	**.79**	.54	.612
15	1.13†	.558	**.655**	.78†	**1.04**	.90	.102
18	1.65†	.775	*.70*	1.092†	**1.45**	1.32	1.153
20	1.98†	.93	**1.40**	.....	**1.74**	.....	.....
22	2.64†	1.24	**1.68**	1.456†	**2.32**	.....	1.564
24	2.97†	1.395	**1.75**	1.872†	**2.61**	2.16	2.04
27	4.81†	2.665	2.80	2.95†	*3.77†*	3.00	3.34
30	5.33†	2.952	.....	*3.40†*	*4.18†*	3.60	4.06
33	6.93†	3.96	.....	*4.05†*	*5.22†*	.....	4.99
36	7.91†	4.51	.....	*4.45†*	*5.95†*	.....	5.42

	3	5	8	12	24	36
Boston	$0.13	$0.21	$0.32	$0.625	$2.05†	$6.05†
Minneapolis	.....	.....	.40	.72	2.55†	5.66†
Denver	.135*	.18*	.27	.47	1.70	.....
Seattle	.13	.....	.36	.72†	2.60†	.....
Los Angeles	16	*.190*	*.270*	**.49**	1.65	.....
New Orleans	.148*	.207*	.345	.586	1.182	.....
Cincinnati	.111	.1665	.259	.4995	1.665	4.92
Atlanta	.11*	.135*	.225	.3825	1.4625	.....
Montreal	68‡	.45†	.70	1.35	4.50†	.....
Detroit	.108	.162	.252	.486	2.205†	5.8425†
Baltimore	.117	.175	.273	.5265	1.755	5.125
Kansas City, Mo	*.132*	**.21**	**.52**	**1.05**	.....	.....
Philadelphia	.12	.18	.28	.54	1.80	4.61

*4-in., 6-in., 9-in., respectively. †Double Strength. ‡3-in. special.

ROAD AND PAVING MATERIALS

ROAD OILS—Following are prices per gallon in tank cars 8,000 gal. minimum f.o.b. place named:

	Aug. 7	One Year Ago
New York, 45% asphalt.....(at terminal)	**$0.055**	$0.0525
New York, 65% asphalt.....(at terminal)	**.06**	.0525
New York, binder.....(at terminal)	**.065**	.06
New York, flux.....(at terminal)	**.04**	.0575
New York, liquid asphalt....(at terminal)	**.06**	.06
St. Louis, 40@50% asphalt	**.0475**	.0535
St. Louis, 50@60% asphalt	**.0481**	.0565
Chicago, 40–50% asphalt	.0525	.0525
Chicago, 60–70% asphalt	.055	.055
Dallas, 45% asphalt	.0495	.049
Dallas, 55% asphalt	.0455	.0455
Dallas, binder	.061	.061
San Francisco, binder, per ton	11.00*	9.50*

* F.o.b. Oelum, Cal. Freight to San Francisco, 80c. per ton.

ASPHALT—Price per ton in packages (350-lb. bbls. or 425-lb. drums) and in bulk in carload lots, f.o.b. points listed:

	Package	Bulk
New York (*Standard refined Mexican*)	$19@20*	$15@16
Boston (*Mexican*)	21.00	16.00
Chicago (*Stanolind*)	21.00	15.00
San Francisco, *f.o.b. refinery*, Oleum, Cal.	17.00	11.00
Dallas (*Texas*)	27.10	21.10
Seattle, "*D*" *grade, California, f.o.b. Richmond*	24.75	20.50
Denver (*California*)	24.00	...
Minneapolis *f.o.b. Twin Cities* (*Stanolind*)	25.10	19.10
St. Louis (*Trinidad*)	33.00	31.00
Baltimore (*Standard Oil*)	18.00	14.00
Montreal (*Imperial*)	28.00	21.00
Atlanta (*Mexican*)	32.00	28.50
Detroit (*Mexican*)	22.00	18.00
Cincinnati (*Kentucky Rock*)	...	11.65
Maurer, N. J. (*Bermudez*)	28.00	26.00
Maurer, N. J. (*Mexican*)	20.50	17.50
Philadelphia (*Mexican*)	22.00	17.00
Kansas City (*Texas*)	27.30	22.30
Los Angeles "*D*" *grade, California, f.o.b. El Segundo Refinery*	17.00	11.00
Birmingham (*Mexican*)	32.00	28.50

*In drums.

NOTE—Barrels or drums are optional in most cities. About 6 bbls. to the ton, and from 4 to 5 drums; 200 to 300 gal. to the ton.

PAVING STONE—

New York (grade I)	5-in. granite, 30 blocks per sq.yd.	$140.00 per M.
Chicago	About 4x8x4 dressed	3.60 per sq.yd.
	About 4x8x4 common	2.95 per sq.yd.
San Francisco	Basalt block 4x7x8	70.00 per M.
Boston	5-in. granite, 28 blocks per sq.yd.	*130.00* per M.
Atlanta	Granite	*2.50* per sq.yd.
Detroit	5-in. Granite	3.00 per sq.yd.
Baltimore	Granite	2.85 per sq.yd.
Montreal	Granite	104.75 per M.
New Orleans	Granite, 4 x 8 x 4	3.25 per sq.yd.
Cincinnati	Granite	*135.00* per M.
St. Louis	4x8x4 dressed	*1.65* per sq.yd.
	4x8x4 common	*1.65* per sq.yd.
Kansas City	Granite	3.85 per sq.yd.
Philadelphia	Granite	3.00@4.25 per sq.yd.
Minneapolis	Sandstone	2.74 per sq.yd.

FLAGGING—

New York	Bronx, 4 ft wide	$0.22 per sq.ft.
	Manhattan, 4 ft. wide	.22 per sq.ft.
	Queens, 5 ft. wide	.24 per sq.ft.
	6x24-in. cross-walk	1.20 per lin.ft.
Chicago	18 in. wide....No market	per lin.ft.

CURBING—*New York*: Bluestone per lin.ft., f.o.b. barge New York, 5 x 16 in., 85c.; 5 x 20 in., Queens, 95c. *St. Louis*: Class "A" straight, delivered, 5 x 16 in., 90c. per lin.ft.

WOOD BLOCK PAVING—

	Size of Block	Treatment	Per Sq.Yd.
New York (*delivered*)	3	16	$2.28
New York (*delivered*)	3½	16	2.48
Boston	3½	18	*2.55*
Chicago	4	16	3.20
Chicago	3½	16	2.90
St. Louis	3½	16	2.35
St. Louis	4	16	2.65
Seattle	4	16	Off market
Minneapolis	3½	16	2.75
Atlanta	3½	16	2.00
New Orleans	3	16	1.70
New Orleans	3½	16	2.10
New Orleans	4	16	2.50
Dallas	4	18	3.90
Baltimore	3½	16	None used
Montreal	4	16	4.50
Detroit	3½	16	2.13
Detroit	4	16	...
Cincinnati	3½	16	2.38
Kansas City	4	16	3.00
Philadelphia	4	16	None used

CONSTRUCTION MATERIALS

SAND AND GRAVEL—Price for cargo or carload lots to contractor is as follows, per cu.yd.:

	Gravel 1½ In.		Gravel ¾ In.		Sand	
	Aug. 7	One Year Ago	Aug. 7	One Year Ago	Aug. 7	One Year Ago
New York (*alongside dock*)	$1.75	$1.75	*$1.75*	$1.75	$1.00	$1.25
Denver	1.90	1.90	1.90	1.90	1.00	1.00
Chicago	2.00	2.00	**2.75**	2.00	**2.75**	2.00
St. Louis	1.45†	2.30†	**1.65**†	2.35†	1.18†	2.10†
Seattle	1.50	1.25	1.50	1.25	1.50	1.25
Dallas	2.38	2.38	2.38	2.38	2.00	1.89
Minneapolis	1.85*	1.85*	1.85*	1.85*	1.25	1.25
Cincinnati	1.40†	1.50†	1.40†	1.50†	1.35†	1.20†
San Francisco	2.15	2.15	2.15	2.15	1.50	1.50
Boston	1.40†	1.50†	1.40†	1.50†	1.00†	1.20†
New Orleans	3.00	2.85	3.00	2.85	1.25	1.25
Los Angeles	*1.45*	2.75†	*1.55*	2.75†	*1.20*	1.75†
Atlanta	*1.90*†	1.90†	*1.40*†	1.90†	1.40†	1.24†
Detroit	2.05	1.62	1.75	1.62	1.35	2.02½
Baltimore	1.40	1.86	1.60	2.06	0.70†	0.80†
Montreal	1.25†	1.25†	1.50†	1.50†	1.25†	1.25†
Birmingham	2.00	...	2.00	...	**1.30**†	1.30†
Philadelphia	2.10	...	2.10	...	1.50	...
Kansas City	...	1.75	...	1.60	0.66*	0.66*

New York—Grits, $1.75 per cu. yd.; ready mixed, $2.00.
Los Angeles—Freight from quarry, 70c. per ton, and is included in above price.
* At pit. † Per ton.

CRUSHED STONE—Price for cargo or carload lots f.o.b. city, unless stated otherwise, is as follows, per cu.yd.:

	1½ In.		¾ In.	
	Aug. 7	One Year Ago	Aug. 7	One Year Ago
New York	$1.75	$1.65	$1.85	$1.75
Chicago	2.00	2.00	2.00	2.00
St. Louis	*1.75**	1.90	1.75*	1.70
Dallas	2.83	2.50	2.83	2.50
San Francisco	2.15	2.15	2.15	2.15
Boston	1.45*	1.70*	1.45*	1.70*
Minneapolis	1.75	2.00	1.75	2.25
Kansas City	1.50	1.50	1.50	1.50
Denver	3.50	3.50	3.50	3.50
Seattle	3.00	3.00	3.00	3.00
Atlanta	2.00*	2.00*	2.00*	2.00*
Cincinnati	1.90*	1.65*	1.90*	1.65*
Los Angeles (F.O.B. quarry)	*1.00*	...	*1.00*	...
Detroit	1.70	1.75	1.70	1.75
Baltimore	2.50	2.50	2.55	2.55
Montreal	1.80*	1.80*	1.90*	1.90*
Philadelphia	2.10	...	2.10	...
Pittsburgh	2.85	2.85	2.85	2.85
Cleveland	3.25*	3.25*	3.25*	3.25*
Birmingham	...	...	...	...

*Per ton.

CRUSHED SLAG—Price of crushed slag in carload lots, per net ton, at plants:

	1½-In.	¾-In.	Roofing	Sand
Youngstown District	$1.30	$1.40	$2.00	$1.30
Steubenville District	1.40	1.40	2.00	1.40
Ironton District	1.40	1.40	2.00	1.40
Easton, Catasauqua, Pa	0.85	0.90	2.50	...
Birmingham, Ala	**1.00**	**1.20**	2.05	...
Buffalo, N. Y., and Erie, Pa	1.25	1.25	2.25	1.25
Cleveland, Ohio	1.45	1.45	1.45	1.25
Eastern Pa. and Northern N. J	1.20	1.20	2.50	1.20
Western Pennsylvania	1.25	1.25	2.00	1.25
Longdale and Glen Wilton, Va	1.25	1.25	2.50	1.00
Toledo, Ohio	1.50	1.50	1.50	1.50

LIME—Warehouse prices:

	Hydrated, per Ton		Lump, per Barrel	
	Finishing	Common	Finishing	Common
New York	$18.20	$13.10	$3.75*	$3.00@3.25*
Chicago	20.00	*18.00*	1.50†	1.50†
St. Louis	24.00	20.00	18.75‡	18.75‡
Boston	20.00	15.00	3.90*	3.10*
Dallas	20.00	...	...	1.85†
Cincinnati	16.80	14.30	...	13.40‡
San Francisco	22.60	22.60	...	2.15†
Minneapolis	25.50	21.00 (white)	1.70†	1.40†
Denver	24.00	...	...	2.70†
Detroit	22.00	20.00	...	20.00‡
Seattle, *paper sacks*	24.00	...	2.80†	...
Los Angeles	...	18.50	...	2.00†
Baltimore	24.25	17.85	2.55†	...
Montreal	21.00	21.00	...	10.50‡
Atlanta	22.50	14.00	*2.10*†	*1.45*†
New Orleans	24.00	18.00	*2.80*†	**2.20**†
Philadelphia	23.00	16.00	22.00‡	1.24†
Kansas City	**22.60**	**22.60**	*2.50**	*2.50**
Birmingham	**18.00**	**14.00**	2.00†	*1.75*†

*Per 280-lb. bbl. (net). †Per 180-lb. bbl. (net). ‡Per ton—Refund of 10c. per bbl. Minneapolis quotes brown common lump lime; Kelly Is. white is $1.80 Sheboygan $1.70. New York quotes hydrated lime "on cars" in paper sacks, lump lime "alongside dealers docks" or "on cars."

NATURAL CEMENT—Price to dealers per bbl. for 500 bbl. or over, f.o.b. exclusive of bags:

	Aug. 7	One Year Ago
Minneapolis (Rosendale)	$2.80	$2.80
Kansas City (Ft. Scott)	*1.50*	1.50
Cincinnati (Utica)	1.72	1.72
Boston (Rosendale)	2.50	2.70
St. Louis (Carney)	*2.35*	2.85
Birmingham (Magnolia) pozzolan cement	2.10	2.10

PORTLAND CEMENT—Prices to contractors per bbl. in carload lots f.o.b points listed *without bags*. Cash discount not deducted.

	Aug. 7	One Month Ago	One Year Ago
New York, del. by truck	$2.50@2.60	$2.50@2.60	$2.70@2.80
New York, alongside dock to dealers	2.15	2.15	2.30
Jersey City	2.33	2.33	2.48
Boston	**2.64**	2.63	2.90
Chicago	2.20	2.20	2.20
Pittsburgh	2.19	2.19	2.24
Cleveland	2.39	2.39	2.46
Detroit	2.40	2.40	2.48
Indianapolis	2.41	2.41	2.41
Milwaukee	2.35	2.35	2.37
Duluth	2.19	2.19	2.25
Peoria	2.37	2.37	2.41
Cedar Rapids	2.40	2.40	2.48
Davenport	2.39	2.39	2.43
St. Louis	2.30	2.30	2.35
San Francisco	2.61	2.64	2.63
New Orleans	**2.80**	2.40	3.20
Minneapolis	2.42	2.42	2.50
Denver	2.84	2.84	2.84
Seattle	2.90	2.90	2.90
Dallas	2.05	2.05	2.25
Atlanta	2.35	2.35	2.85
Cincinnati	**2.52**	2.67	2.54
Los Angeles	*2.75*	3.00	3.16
Baltimore	**2.90**	2.50	2.65
Birmingham	*2.40*	2.65	2.70
Kansas City	**2.82**	2.27	2.55
Montreal	1.90	1.90	2.25
Philadelphia	2.41	2.41	...
St. Paul	2.42	2.42	2.50
Toledo	2.45	2.45	2.48

NOTE—Bags 10c. each, 40c. per bbl.; 20c. each in Canada, 80c. per bbl.

Current mill-prices per barrel in carload lots, without bags, to contractors:

Buffington, Ind	$1.95	Hudson, N. Y.	$2.05
Universal, Pa	1.95	Leeds, Ala	1.95
Steelton, Minn	2.00	Hannibal, Mo	2.05
Fordwick, Va	2.05	Lehigh Valley District	1.95
Mitchell, Ind	2.05	Wyandotte, Mich	2.15
Iola, Kan	1.95	Alpena, Mich	2.00
Mason City, Ia	2.00	Richard City, Tenn	2.05
La Salle, Ill	2.05	Kingsport, Tenn	2.05

TRIANGLE MESH—Price per 100 sq.ft. in carload lots:

PLAIN 4-INCH BY 4-INCH MESH

Style Number	Weight in Pounds per 100 sq.ft.	Pittsburgh Mill	Chicago Mill	Warehouse: New York	St. Louis	Dallas	San Francisco
032	22	$0.95	$1.02	$1.24	$1.04	$1.13	$1.15
049	28	1.20	1.30	1.58	1.32	1.38	1.45
068	35	1.47	1.59	1.94	1.62	1.67	1.78
093	45	1.89	2.04	2.50	2.08	2.00	2.28
126	57	2.34	2.53	3.09	2.59	2.55	2.85
153	68	2.79	3.02	3.60	3.08	3.15	.....
180	78	3.20	3.47	5.22	3.54	3.47	.....
245	103	4.22	4.57	4.60	4.64	4.58	.....
287	119	4.88	5.28	6.44	5.39	5.26	5.84
336	138	5.66	6.13	7.39	6.25	6.11	.....
395	160	6.56	7.10	8.67	7.25	7.12	.....
			PAVING				
036P	17	$0.72	$0.78	$0.95	$0.79	$0.76	.....
053P	24	1.02	1.10	1.35	1.12	1.07	.....
072P	31	1.29	1.40	1.71	1.42	1.39	.....
097P	40	1.66	1.80	2.20	1.83	1.90	.....
049R	24	.....	1.10	.....	1.12	1.07	.....
067R	31	.....	1.40	.....	1.42	1.39	.....
089R	40	.....	1.80	.....	1.83	1.90	.....

In rolls, 48-, 52-, and 56-in. wide and in 150-, 200- and 300-ft. lengths. Galvanized is about 15% higher. Size of roll carried in New York warehouses, 48 in. wide x 150 ft. long, or 600 sq. ft.

EXPANDED METAL LATH—Prices in carload lots per 100 yd. for painted are as follows:

Weight in pounds	New York	Chicago	St. Louis	San Francisco	Dallas
2.2	$21.00	$19.00	$20.00	$22.50	$25.50
2.5	23.00	21.00	21.00	23.50	27.58
3.0	27.00	24.50	26.50	27.00	33.16
3.4	29.00	26.50	29.00	.....	35.10

BARS, CONCRETE REINFORCING—Current quotations per 100 lb.:

ROLLED FROM BILLETS

Inches	Warehouse, Uncut: Pittsburgh Mill	Birmingham	New York	Chicago	St. Louis	Dallas	San Francisco
½ and larger	$2.15	$2.75	$3.24	$3.00	$3.30	$3.38	$3.35
⅜	2.20	2.90	3.34	3.10	3.35	3.43	3.45
¼	2.25	3.00	3.44	3.20	3.50	3.48	3.55
⅛	2.40	3.25	3.64	3.40	3.70	3.63	3.75
⅛	2.65	3.50	4.24	4.00	4.30	3.78	4.35

For size and cutting extras, manufacturers and distributers, see bar card of July 1, 1923.

ROLLED FROM RAILS

	Chicago	St. Louis	Dallas		Chicago	St. Louis	Dallas
½ and larger	$2.70	$3.00	$3.08	⅜	$3.10	$3.20	$3.30
⅜ in.	2.80	3.05	3.13	¼	3.70	3.50	5.48
¼	2.90	3.10	3.18	.....	.....	.....	.....

BRICK—Contractors price per 1,000 in cargo or carload lots is as follows:

	Common: Aug. 7	One Month Ago	One Year Ago	Paving Block: 3-inch*	4-inch*
New York (del.)	$20.15	$23.65	$24.60@25.70	$46.50	$53@54
New York (at dock)	16@17	20.00	21@22	.....	.....
Chicago	15.00	11.00	11.00	34.00	42.00
St. Louis, salmon	16@18	16@18	16@18	38@40	40@42.50
Denver, salmon	12.00	12.00	12.00	.....	.....
Dallas	14.10	14.10	13.10	35.00	.....
San Francisco	15.50	15.50	15.00	.....	.....
Los Angeles	15.00	14.50	16.00	(not used)	
Boston (del.)	21.50	21.50	22.00	47.50	55.00
Minneapolis (del.)	13.00	13.00	17@19	.....	.....
Kansas City	16.50	16.50	14.50	(no market)	
Seattle	15.00	15.00	13.00	.....	58.50
Cincinnati	17.00	17.00	17@20	40.00	45.00
Montreal	17.50	17.50	16.50	100.00†	68.00
Detroit (del.)	17.50	17.50	19.00	38.50	41.50
Baltimore	18.00	18.00	21.00	40.00	45.00
Atlanta	11.00	11.00	12.00	40.00	45.00
New Orleans	19.50	19.50	18.75	.....	.....
Birmingham	12.50	12.50	13.50@16	(no market)	
Philadelphia	19.00	19.00	.....	38.00	46.00
Pittsburgh (del.)	16.00	16.00	16.00	.....	.....
Cleveland	16.00	16.00	16.00	.....	.....

* For paving blocks 3½x8½x3 and 3½x8½x4 respectively. † Imported.

HOLLOW TILE—Price per block in carload lots to contractor for hollow building tile.

	New York: Aug. 7 on Trucks*	New York: One Year Ago	Chicago	Philadelphia	St. Louis	San Francisco	Perth Amboy N. J., Factory*
4x12x12	$0.1162	$0.1573	$0.089	$0.125	$0.077	$0.108	.....
6x12x12	.1743	.2097	.114	.....	.103	.156	.....
8x12x12	.2179	.2621	.163	.215	.14	.244	.....
10x12x12	.....	.....	.210	.....	.170	.....	$0.2786
12x12x12	.....	.....	.250	.....	.21	.....	.3448

* 5 per cent off for cash.

	4x12x12	8x12x12	12x12x12
Boston	$0.125	$0.23	.....
Minneapolis (f.o.b. cars)	.073	.12	$0.215
Minneapolis (delivered)	.08	.13	.23
Cincinnati	.07485	.13745	.....
Kansas City	.085	.145	.....
Denver	.085	.155	.188
Seattle (delivered)	.11	.25	.36
Los Angeles	.085	.172	.....
New Orleans	.14	.24	.....
Detroit (delivered)	.1044	.1958	.2737
Montreal	.12	.225	.30
Baltimore	.125	.27	.....
Atlanta	.10	.1674	.....
Dallas	.11	.20	.285
Birmingham	.11	.175	.....
Pittsburgh (delivered)	.068	.128	.179
Cleveland	.08	.14	.....

San Francisco and New York quote on hollow partition tile.

STRUCTURAL MATERIAL—Following are base prices f. o. b. mill, Pittsburgh and Birmingham, together with quotations per 100 lb. from warehouses at places named:

	Pittsburgh Mill	Warehouse: Birmingham	New York	Dallas	St. Louis	Chicago	San Francisco
Beams, 3 to 15 in.	$2.15	$2.75	$3.34	$4.20	$3.25	$3.10	$3.40
Channels, 3 to 15 in.	2.15	2.75	3.34	4.20	3.25	3.10	3.40
Angles, 3 to 16 in., ¼ in. thick	2.15	2.75	3.34	4.20	3.25	3.10	3.40
Tees, 3 in. and larger	2.15	2.75	3.34	4.20	3.30	3.10	3.40
Plates, ¼ in. thick and heavier	2.15@2.20	2.50	3.34	4.30	3.25	3.10	3.40

RIVETS—The following quotations are per 100 lb.:

STRUCTURAL

	Pittsburgh Mill	Warehouse: New York—Aug. 7	New York—One Yr. Ago	Chicago	St. Louis	San Francisco	Dallas
½ in.	$2.45@2.50	$4.00	$4.40	$3.75	$3.65	$5.00	$4.90
		CONE HEAD BOILER					
½ in.	$3.00	$4.10	$4.50	$3.85	$3.85	$5.20	$5.00
⅝ and ¾	3.15	4.26	4.66	4.00	4.20@4.45	5.35	5.15
⅞ and 1	3.40	4.50	4.90	4.25	4.60	5.60	5.50

NAILS—The following quotations are per keg from warehouse:

	Pittsburgh Mill	Birmingham	Chicago	San Francisco	Dallas	St. Louis	Montreal
Wire	$2.85	$3.75	$3.80	$4.10	$4.55	$3.24	$4.95
Cut	2.90	4.25	4.45	5.25	5.75	3.49	5.00

SHIP SPIKES—Current prices per 100 lb.:

In.	San Francisco: Galv.	San Francisco: Black	Seattle Black
½	$8.25	$6.20	$7.75
⅜	7.80	5.80	5.75
¼	7.65	5.65	5.35

Pittsburgh base in lots of 200 kegs or more, $3.25@3.40.

PREPARED ROOFINGS—Slate-surfaced roofing (red and green) in rolls of 108 sq.ft. costs $2.64 per roll to consumers in less than carload lots f.o.b. Philadelphia.

Single shingles, red and green slate finish, cost $6.95 per square (sufficient to cover 100 sq.ft.) in less than carload lots, f.o.b. Philadelphia. Strip shingles (4 in l) f.o.b. Philadelphia, l.c.l., $6.05 per square.

ROOFING MATERIALS—Prices f.o.b. New York, to consumers in less than carload lots:

Tar felt (14 lb. per square of 100 sq.ft.) per ton	$85.75
Tar pitch (in 400-lb. bbl.), per 100 lb.	2.13
Asphalt roofing (in barrels), per ton, f.o.b. plant*	40.50
Asphalt felt (light), per ton, f.o.b. plant*	87.75
Asphalt felt (heavy), per ton, f.o.b. plant*	87.75

* Delivered in Metropolitan Dist., $2.00 additional.

WINDOW GLASS—United inches, 25, bracket size 6x8 to 10x15, single thickness "AA," 82 per cent; "A," 86 per cent; "B," 88 per cent. Double thickness "AA," 82 per cent; "A," 85 per cent; "B," 88 per cent discount from jobbers list at New York warehouses.

SHEETS—Quotations are per 100 lb. in various cities from warehouse also the base quotations from mill:

Blue Annealed	Pittsburgh Large Mill Lots	St. Louis	Chicago	San Francisco	New York
No. 10	$2.70@2.80	$3.90	$3.80	$4.75	$4.14
No. 12	2.85@2.90	3.95	4.05	4.80	4.19
No. 14	2.95@3.00	4.00	4.10	4.85	4.24
No. 16	2.15@3.20	4.10	4.20	4.95	4.34
Black					
*Nos. 18 and 20	3.60@3.70	4.45	4.55	5.35	4.65
*Nos. 22 and 24	3.65@3.75	4.50	4.55	5.40	4.70
*No. 26	3.70@3.80	4.55	4.60	5.45	4.75
*No. 28	3.50@3.65	4.65	4.50	5.55	4.85
Galvanized					
No. 10	$3.85@3.95	4.65	4.60	5.25	4.90
No. 12	3.95@4.05	4.75	4.70	5.35	5.00
No. 14	3.95@4.05	4.75	4.70	5.35	5.00
Nos. 17 to 21	4.25@4.35	5.05	5.00	5.65	5.30
Nos. 22 and 24	4.35@4.45	5.20	5.15	5.80	5.45
*Nos. 25 and 26	4.45@4.55	5.35	5.30	5.95	5.55
*No. 28	4.75@4.85	5.65	5.50	6.25	5.85

*For painted corrugated sheets add 30c. per 1,000 lb. for 5 to 28 gage; 25c. for 19 to 24 gages; for galvanized corrugated sheets add 15c., all gages.

LINSEED OIL—These prices are per gallon:

	New York: Aug. 7	New York: One Year Ago	Chicago: Aug. 7	Chicago: One Year Ago
Raw in barrels (5 bbl. lots)	$1.05	$1.05	$0.94	$1.28

WHITE AND RED LEAD—In 100-lb. kegs, base price in cents per pound:

	Dry		In Oil	
	Aug. 7	1 Yr. Ago	Aug. 7	1 Yr. Ago
Red	14.50	14.00	16.00	15.50
White	14.50	14.00	14.50	14.00

LUMBER

Prices wholesale, per M. ft. b.m., to dealers in carload lots, f.o.b.

San Francisco—Prices of rough Douglas fir No. 1 common, in carload lots to dealers at yards. To contractors, $2 per M. ft. additional.

	6-8 and 12 Ft	10-16-18 and 20 Ft.	22 and 24 Ft	25 to 32 Ft.
3x3 and 4	$30.00	$31.00	$32.00	$35.00
3x6 and 8	30.00	31.00	32.00	35.00
4x4-6 and 8	30.00	31.00	32.00	35.00
3x10 and 12	30.00	31.00	32.00	35.00
3x14	34.00	34.00	36.00	38.00
4x10 and 12	30.00	31.00	32.00	35.00
4x14	34.00	34.00	36.00	38.00

	24 Ft. and Under	25 to 32 Ft.	33 to 40 Ft.
6x10	$32.00	$34.00	$36.00
6x14	32.00	34.00	36.00
8x10	32.00	34.00	36.00
8x14	32.00	34.00	36.00

New York and Chicago—Wholesale prices to dealers of long leaf yellow pine.

	New York*		Chicago	
	20 Ft. and Under	22-24 Ft.	20 Ft. and Under	22-24 Ft.
3x4 to 8x8	$42.00	$43.00	$52.00	$56.00
3x10 to 10x10	46.00	47.00	53.00	57.00
3x12 to 12x12	52.00	53.00	55.00	58.00
3x14 to 14x14	60.00	61.00	57.00	60.00
3x16 to 16x16	70.00	71.00	64.00	65.00
3x18 to 18x18	.....	.....	68.00	69.00
4x20 to 20x20	.....	.....	70.00	71.00

*Wholesale price to dealers; to contractors, delivered from lighters or cars to ob, $5 additional. Short leaf pine costs $3 per M. less.

Over 24 ft.—Add $1 for each additional 2 ft. in length up to 30 ft. for sizes 12 x 12 and under, for sizes over 12 x 12 add $2, for merchantable add $2 to sizes 10 x 10 and under.

Other Cities

	8x8-In. x 20 Ft. and Under				12x12-In. 20 Ft. and Under	
	P.	Fir*	Hemlock	Spruce	P.	Fir*
Boston	$57.00	$56.00†	$50.00	$50.00	$65.00	$65.00†
Seattle	.....	29.50	.....	.....	.....	23.00
New Orleans	29.00	.....	.....	.....	39.00	.....
Baltimore	32.50	49.25	53.00	60.00	38.00	49.75
Cincinnati	40.00	74.00	74.00	88.00	44.00	78.00
Montreal	50.00	58.00	.....	.....	60.00	65.00
Los Angeles	.....	37.00	.....	.....	.....	38.00
Denver	.....	33.75	33.75	33.75	.....	34.75
Minneapolis	40.00	37.75	39.00	.....	43.10	37.75
Atlanta	33.00	.....	.....	.....	36.00	.....
Dallas	52.25	.....	.....	.....	57.20	.....
Kansas City	43.50	48.50	.....	.....	54.50	49.50
Birmingham	20@30	.....	.....	.....	25@33	.....
Philadelphia	41.00	36.00	41.50	43.00	51.00	37.00
Detroit	40.75	46.75	.....	.....	49.75	46.75
St. Louis	42.00	.....	.....	.....	54.00	.....

	1-In. Rough, 10 In. x 16 Ft. and Under			2-In. T. and Gr. 10 In. x 16 Ft.	
	P.	Fir*	Hemlock	P.	Fir*
Boston	$46.00	$45.00†	$45.00	$52.00	$51.00†
Seattle	.....	25.00	.....	.....	29.00
New Orleans	67.00	.....	.....	33.00	.....
Baltimore	55.00	44.00	44.00	34.00	50.00
Cincinnati	75.00	80.00	75.00	38.00	88.00
Montreal	56.00	50.00	45.00	45.00	45.00
Los Angeles	.....	49.00	.....	.....	.....
Denver	.....	33.25	34.25	.....	29.25
Minneapolis	43.00	35.25	35.50	37.00	32.25
Atlanta	32.00	.....	.....	35.00	.....
Dallas	52.25	.....	.....	55.73	.....
Kansas City	80.50	46.00	.....	77.50	.....
Birmingham	.....	.....	.....	24@42	.....
Philadelphia	29.00	36.00	41.00	41.00	35.00
Detroit	38.75	35.00	.....	44.00	36.75
St. Louis	41.00	.....	.....	30.00	.....

Birmingham—Quotes carload lots, f.o.b. sidings; $4.00 additional per M.ft. to contractors.
Boston and Cincinnati—Prices to contractors in carload lots, f.o.b.
Denver—Quotes dealers price to contractors on large projects.
St. Louis—Wholesale price to contractors, f.o.b. cars, $3 per M.ft. additional.
Seattle—Price to contractors, delivered.
Dallas—Wholesale to contractors, $10 per M.ft. additional.
*Douglas fir. †Prime.

PILES—Prices per lineal foot, pine piles with bark on, f.o.b. New York.

Diameters	Points	Length	Barge	Rail
12 in. at butt	6 in.	30 to 50 ft.	$0.14½	$0.18½
12 in.—2 ft. from butt	6 in.	50 to 59 ft.	.19	.23½
12 in.—2 ft. from butt	6 in.	60 to 69 ft	.21½	.25½
14 in.—2 ft. from butt	6 in.	50 to 69 ft.	.25½	.34
14 in.—2 ft. from butt	6 in.	70 to 79 ft.	.27½	.36½
14 in.—2 ft. from butt	5 in.	80 to 89 ft.	.35	.41

MISCELLANEOUS

STEEL SHEETPILING—The following price is base per 100 lb. f.o.b. Pittsburgh, with a comparison of a month and a year ago:

Aug. 7	One Month Ago	One Year Ago
$2.30@2.40	$2.35@2.40	$2.65

WIRE ROPE—Discounts from list price on regular grades of bright and galvanized are as follows:

	Eastern Territory New York and East of Missouri River
Plow steel round strand rope	35%
Special steel round strand rope	30%
Cast steel round strand rope	20%
Round strand iron and iron tiller	5%
Galvanized steel rigging and guy rope	7½%
Galvanized iron rigging and guy rope	+12½%

California, Oregon, Nevada and Washington Discount: 5 points less than discount for Eastern territory.
Wyoming, New Mexico and Colorado: Discount 5 points less than discount for Eastern territory.
Arizona: Discount 10 points less than discount for Eastern territory.
Montana, Idaho and Utah: Discount 10 points less than discount for Eastern territory.
North Dakota, Nebraska, Kansas, Oklahoma and Texas: Discount 5 points less than discount for Eastern territory.

MANILA ROPE—For rope smaller than ¼-in. the price is ¼ to 2c. extra; while for quantities amounting to less than 600 ft., there is an extra charge of 1c. The number of feet per pound for the various sizes is as follows: ¼-in., 8 ft., ⅜-in., 4; ½-in., 4½; ¾-in., 3½; 1-in., 2½; 1¼-in., 2 ft. 10 in.; 1½-in., 2 ft. 4 in. Following is price per pound for ¼-in. and larger, in 1200-ft. coils:

Boston	$0.17½@.22	New Orleans	$0.17½
New York	.18½	Los Angeles	.20
Chicago	.18	Seattle	.18
Minneapolis	.19½	St. Louis	.18½
San Francisco	.17	Montreal	.16
Atlanta	.21	Detroit	.20
Denver	.19½@20½	Baltimore	.18
Cincinnati	.21	Kansas City	.20½
Dallas	.21	Birmingham	.23
Philadelphia	.18½		

EXPLOSIVES—Price per pound of dynamite in small lots:

	Gelatin 40%	Gelatin 60%
New York	$0.27	$0.295
Boston	.23	.25
Kansas City	.2185	.2385
Seattle	.165	.19
Chicago	.22	.25
Minneapolis	.1917	.2123
St. Louis	.22	.245
Denver	.2025	.2275
Dallas	.225	.302
Los Angeles	.1925	.2225
Atlanta	.23	.255
Baltimore	.22	.23
Cincinnati	.22	.245
Montreal	.195	.235
Birmingham	.21	.24
New Orleans	.235	.29
San Francisco	.1625	.1925
Philadelphia	.215	.24

CHEMICALS—Water and sewage treatment chemicals, spot shipments in carload lots, f. o. b. New York:

Sulphate of aluminum, in bags, per 100 lb	$1.35@1.40
Sulphate of copper, in bbl., per 100 lb	4.65@4.80
Soda ash, 58%, in bags, per 100 lb	1.25@1.45
Chlorine, liquid, cylinders, 100 lb., per lb. (f.o.b. works)	.05½@.07½
Hypochlorite of lime (bleaching powder) in drums, per 100 lb	2.25@2.35

FREIGHT RATES—On finished steel products in the Pittsburgh district, including plates, structural shapes, merchant steel, bars, pipe fittings, plain and galvanized wire nails, rivets, spikes, bolts, flat sheets (except planished), chains, etc., the following freight rates are effective in cents per 100 lb., in carloads of 36,000 lb.:

Baltimore	$0.31	Detroit	$0.29
Birmingham	.58	Kansas City	.735
Boston	.365	New Orleans	.67
Buffalo	.265	New York	.34
Chicago	.34	Pacific Coast (all rail)	1.15*
Cincinnati	.29	Philadelphia	.32
Cleveland	.215	St. Louis	.43
Denver	1.15*	St. Paul	.60

* Minimum carload, 50,000 lb., structural steel only; 80,000 lb., for other iron or steel products.